POWER

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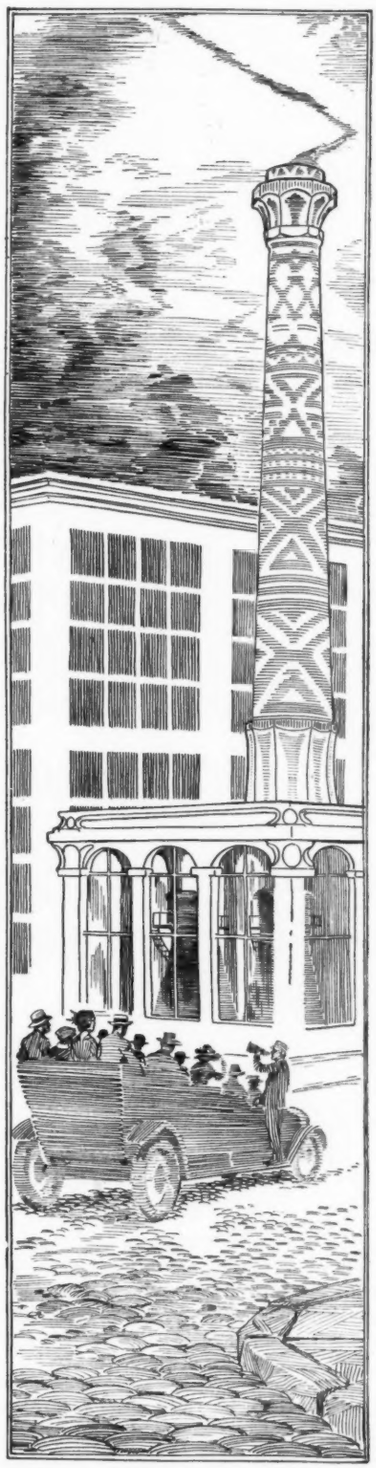


THE SLOGAN

By Berton Braley

You may fill your plant with each new device
That the market holds, you may blithely hire
Efficiency men at the highest price
Who will change things 'round to their hearts' desire,
You may have a place that the crowds admire
For its polished brass and its engines neat,
But it won't be just what you most require
If it doesn't show in the profit sheet.

You may pay for the smartest of trade advice,
On the way to coal and the way to fire,
You may fall for the catalogs that entice
With many things for the wary buyer,
In patent fuel you may take a flyer
("The smallest cost for the greatest heat")
But of each and all you will swiftly tire
If it doesn't show in the profit sheet.

Though "power from a central plant" sounds nice,
If it doesn't pay it will rouse your ire,
And you look with an eye as cold as ice
On the man who raises expenses higher,
Yes, your plant might waken a poet's lyre
To passionate ballads, clear and sweet,
But your satisfaction would soon expire
If it didn't show in the profit sheet.

You can give this out to the public crier
As a phrase of wisdom he can repeat,
"We're strong for progress, but we require
That it all must show in the profit sheet!"

Lake View Pumping Station

By Thomas Wilson

SYNOPSIS—A 100,000,000-gal. station with unusual provisions against shutdown. Features are duplicate discharge mains, hydraulically operated water valves, centrally controlled, complete gravity oiling and filtering system, double coal- and triple ash-handling facilities, vertical steam headers and special metering feed-water pumps.

The Lake View Pumping Station serving Chicago has been passing through a reconstruction period. As far back as 1908 the increasing demand required additional pumping capacity. The pumps then in service were old and used an excessive amount of steam, and the boilers were unable to furnish steam in excess of 100-lb. pressure. At this time the construction of a new engine house was started with space for four vertical triple-expansion pumping engines of 25,000,000-gal. capacity each per 24 hr. One pumping engine was installed in 1910, which was a duplicate of two purchased and installed at the same time for Roseland Pumping Station. These pumps were of the slow-speed type, the maximum capacity being based on a plunger speed of 250 ft. per min. The Lake View pump was moved to the Roseland Station after three pumping engines of the mechanically controlled water-valve type had been installed. To maintain the service while the new pumps were being installed and the old ones removed, a temporary installation of two centrifugal pumps of 20,000,000 gal. each, was made. A temporary boiler plant was erected to serve the centrifugals, and the new pumps when ready for service, until such time as the old plant could be torn down and a new boiler house built on the same site to supply steam at the pressure and superheat called for by the new units.

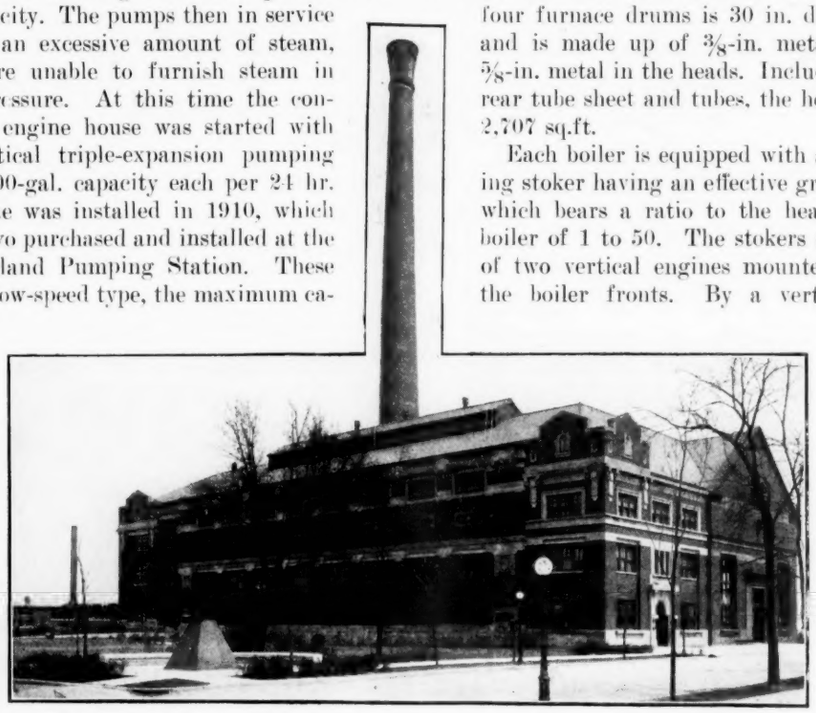


FIG. 1. LAKE VIEW PUMPING STATION, CHICAGO

The new engine house was to contain four pumps rated at 25,000,000 gal. each. The last of these units was installed in 1915, and in July of the same year the new boiler plant was ready for operation. The equipment consists of 1,600 hp. in boilers, an independently fired superheater, coal-handling conveyors, weigh hoppers and large storage bunkers, ash-handling devices and a complete equipment of boiler-room instruments. The capacity of the new plant is 100,000,000 gal. per 24 hr. against an average head of 130 ft. with steam at 175 lb. gage at the throttle and 200 deg. of superheat. A duty on test close to 200,000,000 ft.-lb. per 1,000 lb. of steam is expected.

The boiler room contains five Sederholm return-fire-tubular boilers set singly and rated at 320 hp. each. They are designed for a normal working pressure of 180 lb. gage. This type consists essentially of a fire-tube boiler under which are four transverse furnace drums to improve the circulation and prevent contact of the hot furnace gases with the main shell plate. As a consequence the steaming capacity is increased by the utilization of the radiant heat of the furnace impinging on the furnace drums. The main shell, which is made up of metal $\frac{15}{16}$ in. thick, is 16 ft. 9 in. long and 90 in. diameter. It contains 202 three-inch tubes 16 ft. long. Each of the four furnace drums is 30 in. diameter, 12 ft. long and is made up of $\frac{3}{8}$-in. metal in the shell and $\frac{5}{8}$-in. metal in the heads. Including furnace drums, rear tube sheet and tubes, the heating surface totals 2,707 sq.ft.

Each boiler is equipped with an automatic traveling stoker having an effective grate area of 54 sq.ft., which bears a ratio to the heating surface in the boiler of 1 to 50. The stokers are driven by either of two vertical engines mounted on galleries near the boiler fronts. By a vertical shaft running through the boiler-room floor each engine connects with a countershaft in the basement, the connections being made at both ends with spiral gears. The countershaft and the main stoker shaft are joined by a steel roller chain in connection with friction clutches on the main lineshaft. From the latter each stoker has an individual drive consisting of a variable-speed pulley, a vertical shaft and a worm gear at the stoker. The variable-speed pulley is adjustable from the boiler-room floor by means of a hand-wheel with chain connections. The main lineshaft is divided into three sections joined by clutches, so that the entire shaft need not be maintained in operation, and in order that the stoker of the superheater may be operated at all times regardless of which boilers are in service.

As shown in Fig. 4, the boilers are lagged on top and a passage is provided for the gases over the boiler shell to the uptake at the rear. The uptake rises to the main smoke flue, which serves two boilers and the superheater and passes into a brick stack located midway in the length of the boiler room. An independent flue on the opposite side serves the other three boilers. The stack rests on caisson piers and above its base rises 215 ft. 6 in., or 172 ft. above the bottom of the smoke flue. At the top it has an internal diameter of 6 ft. 6 in. and at the base an external diameter of 18 ft. 6 in. For 72 ft. above the

base of the smoke-flue opening the stack is lined with radial brick.

Each furnace drum has at either end a blowoff which is provided with an angle and a rotating flat disk blowoff valve, making four blowoff valves per drum, or a total of 16 per boiler. The stop and check valves are provided with emergency control valves mounted in glass-front cases on the sides of the settings within easy reach of the boiler-room floor. Flue-gas sampling pipes leading into the rear of the combustion chamber and into the uptake have been provided. The pipes from each unit are connected to independent filters to which an Orsat can be connected. On each boiler front is an indicating thermo-electric pyrometer having a maximum temperature range of 2,500 deg. F. The leads from the instruments permit of indicating the temperature at the rear of the combustion chamber, at the front end of the boiler near the upper end of the shell and at the uptake just below the damper. Another useful instrument is a differential draft gage with connections over the fire and to the uptake, so that the draft may be measured at either point or the drop through the setting determined. One of the boilers has been equipped with a boiler-efficiency meter of the thermo-electric type. This meter both indicates and records the combined boiler and furnace efficiency. It has connections to the furnace and to the uptake, and provisions have been made in the other boilers for similar connections. The superheater is of the direct-fired Schmidt type having a capacity to superheat 28,000 lb. of saturated steam per hour at a normal working pressure of 180 lb. per sq.in. to a final temperature of 560 to 580 deg. F. The superheating elements consist of an upper and lower series of self-draining coils connected to cast-steel headers, which have a total surface of 1,600 sq.ft. The stoker, which is of the same type as those serving the boilers, has an effective grate area of 21 sq.ft.

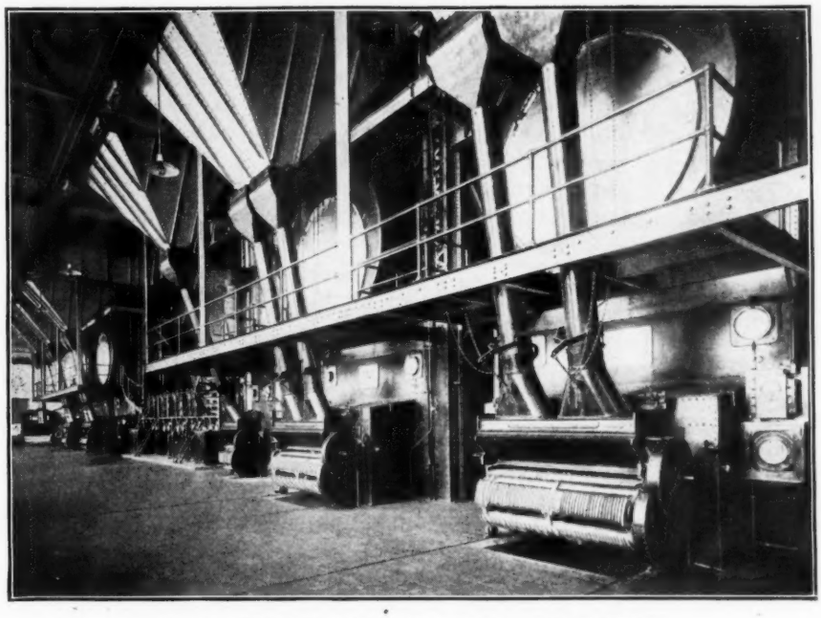


FIG. 2. BOILER ROOM OF LAKE VIEW STATION

The coal-handling system consists of two separate pivoted-bucket continuous conveyors each about 500 ft. long. One of the conveyors serves the boiler room and the other a coal-storage structure built at right angles, holding about 3,000 tons. The coal is brought into the plant by automobile trucks and dumped into a weighing hopper under the driveway through hydraulically operated trap-doors on either side of the scale platform. The hydraulic control valve is located inside of the boiler room adjacent to the scale beam. From the hopper the coal is discharged onto a 30-in. apron conveyor delivering to a four-roll, two-speed, motor-driven crusher. From the latter the coal may pass either to the boiler-house conveyor or to the conveyor serving the storage bunkers. The boilers and the superheater have two individual steel hoppers each. The upper hopper of each pair, having a capacity of 70 tons, is provided with a hydraulically operated gate through which the coal is dumped into the lower weighing hopper, which has a capacity of 20 tons. The scale beams are on the third-floor gallery. Through specially designed coal gates and double spouts the coal drops to the stoker hoppers.

Provision is made to transfer the coal from the storage to the boiler-house conveyor, and in case both conveyors are out of order, coal may be delivered to the overhead bunkers by means of industrial cars. Auxiliary doors have been provided in the storage bunkers, from which the cars may be filled. They are then raised to the third floor by a standard elevator, and the coal is dumped through side doors in the supply bunkers. The capacity

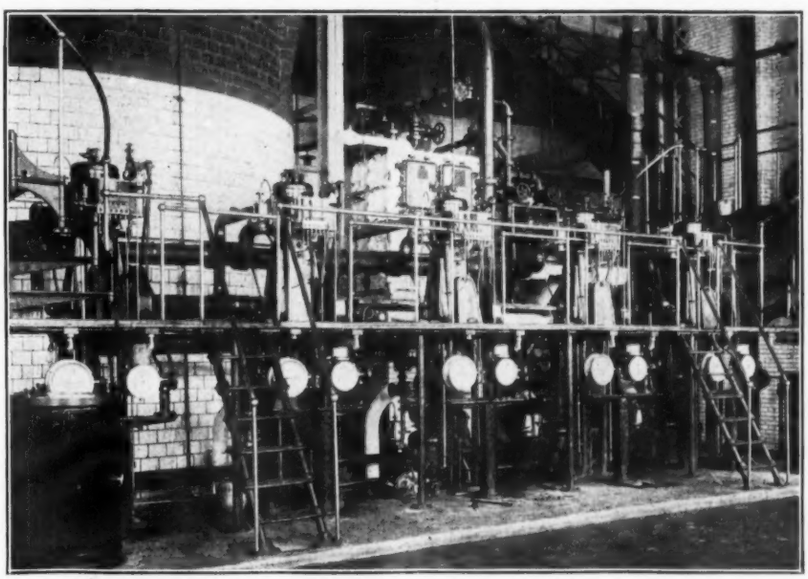


FIG. 3. METERING BOILER-FEED PUMPS

of either conveyor and that of the crusher is 40 tons of coal per hour.

In the crusher pit, shown in Fig. 5, a laboratory coal sampler has been provided. Part of the coal from the crusher is delivered to the boot of a small bucket elevator, which raises it to the top of the sampler. It then passes through a grinder and a sample subdivider, part of it eventually entering a container from which the samples are drawn off into cans, while the balance of the coal is diverted back to the conveyor.

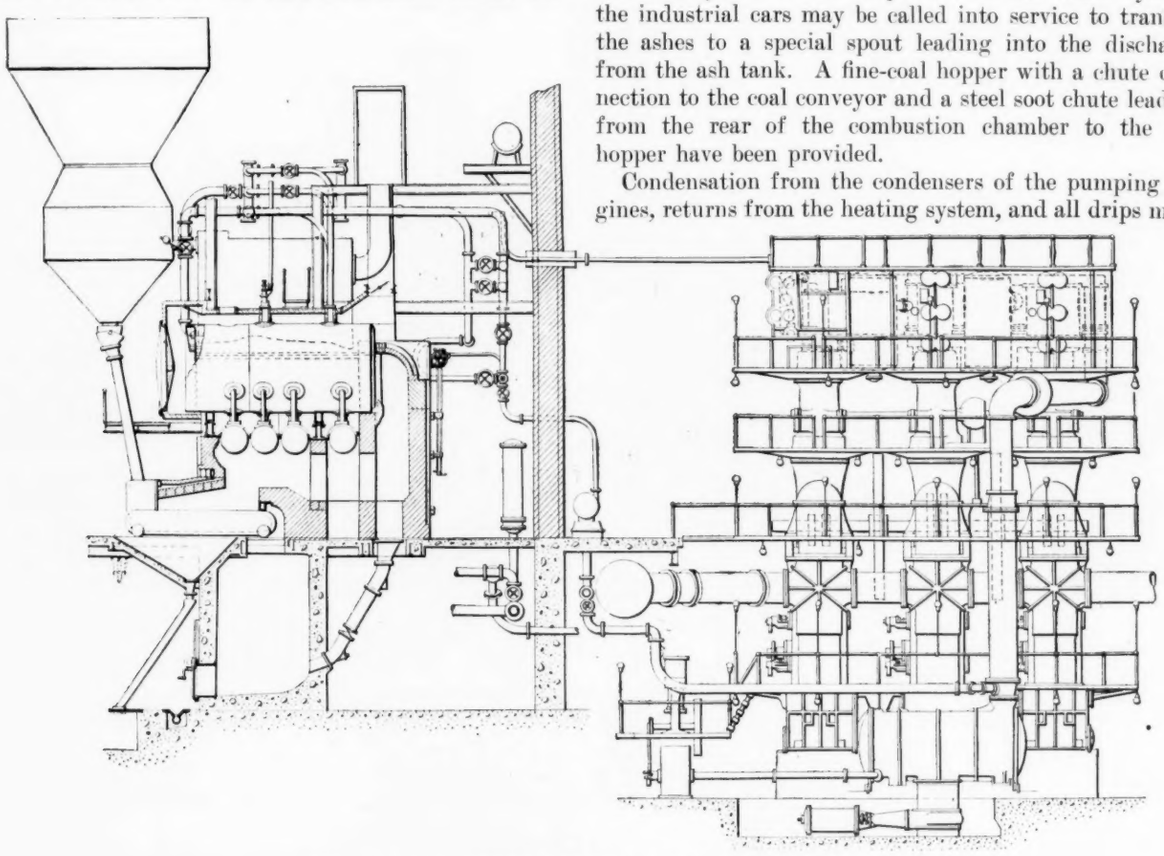


FIG. 4. TRANSVERSE SECTION THROUGH STATION

TABLE 1. PUMPING-ENGINE DIMENSIONS

Normal capacity per 24 hr., U. S. gal.	25,000,000
Normal speed, r.p.m.	62
Maximum speed, r.p.m.	73
Normal head, not including friction through suction piping and pump, ft.	120
Maximum head, not including friction through suction piping and pump, ft.	140
Normal temperature of steam at engine throttle, deg. F.	560
Maximum temperature of steam at engine throttle, deg. F.	600
High-pressure steam-cylinder diameter, in.	15
Intermediate-pressure steam-cylinder diameter, in.	29
Low-pressure steam-cylinder diameter, in.	50
Diameter of each pump plunger, in.	24.125
Stroke common to main steam pistons and main pump plungers, in.	48
Diameter of shaft in flywheel, in.	13
Area of each main-pump water valve, sq.in.	424
Cooling surface, suction surface condenser, sq.ft.	1,100
Size of suction gate valve, in.	42
Diameter, suction nozzle, condenser, in.	42
Diameters of pump suction nozzles, in.	36
Diameters of pump discharge nozzles, in.	30
Diameter of main-station discharge piping, in.	48
Diameter of flywheels, ft.	13
Weight of each flywheel, lb.	18,000

Triple provision has been made for handling the ashes. Each stoker has a concrete ash hopper provided with a hand-operated rack-and-pinion sliding gate that may be opened to any point desired. Ordinarily the ashes are raked into a steam-vacuum ash-handling system made up of 8-in. pipe having a horizontal run of 155 ft. and a vertical rise of 65 ft. to a concrete-lined steel tank which discharges into the wagons on the platform scale used for weighing the coal.

If the steam-vacuum system should be out of order, the ashes may be delivered to the same tank by means of the coal conveyor. If it is impossible to use either system, the industrial cars may be called into service to transfer the ashes to a special spout leading into the discharge from the ash tank. A fine-coal hopper with a chute connection to the coal conveyor and a steel soot chute leading from the rear of the combustion chamber to the ash hopper have been provided.

Condensation from the condensers of the pumping engines, returns from the heating system, and all drips make up the bulk of the feed water supplied to the boilers. Any additional supply necessary is drawn from the city mains. Each boiler is provided with a water-metering feed pump, making a total of five for the plant. These pumps are of the single, vertical-differential, outside-packed type with mechanically controlled water valves. As they have practically no slippage, counting the displacements will give the volume of water handled to within ½ of 1 per cent. Each is driven by a simple

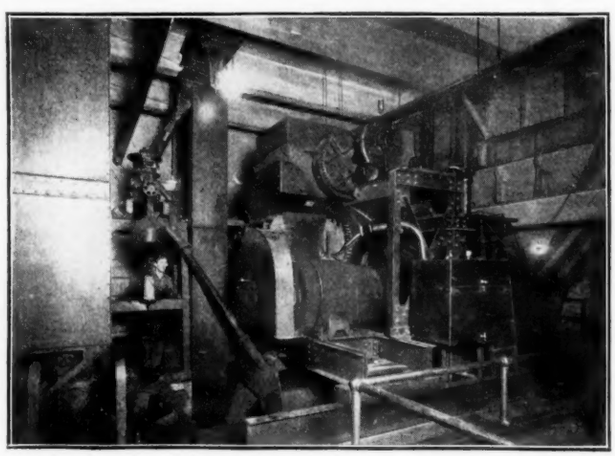


FIG. 5. COAL CRUSHER PIT; COAL SAMPLER AT LEFT

vertical flywheel piston-valve engine. At 120 r.p.m. and with a steam pressure at the engine throttle of 150 lb., the pump will deliver 24 gal. of water per minute against a pressure of 200 lb. The pumps take their suction from either one of two 1,000-hp. open heaters, and individually each may discharge through a closed heater to its particular boiler or to a common header connecting with all the boilers. In case of emergency a steam-turbine driven centrifugal pump having a capacity of 500 gal. per min. and two direct-acting duplex feed pumps have been provided.

Each vertical pump is equipped with an 8-figure revolution counter and an indicating and recording tachometer driven from the crankshaft of the engine. A boiler-compound-solution pump with a variable-stroke device is attached to each unit. The governor is of the throttling speed-control type provided with a speed adjustment that may be operated from the boiler-room floor. In general the plan of the high-pressure steam piping consists of two sets of vertical headers. One set, called the saturated steam headers, is located above the superheater. This consists of two special header castings receiving steam from each boiler through 5-in. lines. The other set, called the distributing headers, consists of three header castings located on a platform near the engine-room wall. The pipes supplying steam to the main pumping engines and auxiliaries connect to these headers. The boiler-feed pumps and stoker engines are supplied by a steam line connected to the bottom of the saturated steam headers. Each set of headers is cross-connected, so that the steam from any boiler may be admitted to either of the two vertical saturated headers and the supply to any pumping engine may be taken from any one of the vertical supply headers. Two separate 7-in. connections are provided between the saturated-steam headers and the distributing headers. One of these connections is arranged so that the steam may pass through the superheater or bypass it. The other connection (intended for emergency) provides for saturated steam only and connects the side of the rear saturated header directly with the top of one of the distributing headers. Where possible, long-radius bends are employed and straightway valves of the carrier block type are used throughout.

The four pumping engines are of the Riedler type with mechanically controlled water valves which permit a plunger speed of 500 ft. per min. This type has shorter stroke and weighs less than the slower-speed type of pump of the same capacity. They were purchased on the basis of the city's design, plans being prepared under the direction of Col. Henry A. Allen, the mechanical engineer in charge, being similar with the exception of minor details and dimensions to the general design of the pumping engines at the Chicago Avenue Pumping Station, which were installed in 1904. By getting bids from competing firms on the same design, the cost per unit was less than $90,000, as compared with the former cost of about $125,000 for the slower-speed type of pump of the same capacity.

The pumps are of the triplex, single-acting type, the mechanically controlled water valves being controlled by a fork-and-stem receiving motion from a wristplate driven by an eccentric on the mainshaft. The engines are of the vertical triple-expansion condensing type with double-beat poppet valves on the high-pressure cylinder suitable for the high superheat, which may give a steam temperature of 600 deg. F., while the other two cylinders have Corliss valves. The normal capacity of each pump is 25,000,000 U. S. gal. per 24 hr. against a normal head of 120 ft. (not including the hydraulic friction through the suction piping and pump) when running at a speed of 62 r.p.m., with superheated steam at a temperature of 560 deg. F. and a pressure of 175 lb. gage at the engine throttle. Each pump, however, is capable of running at a maximum speed of 73 r.p.m. and of pumping water under maximum head conditions of 140 ft. Table 1 gives the principal dimensions of these units.

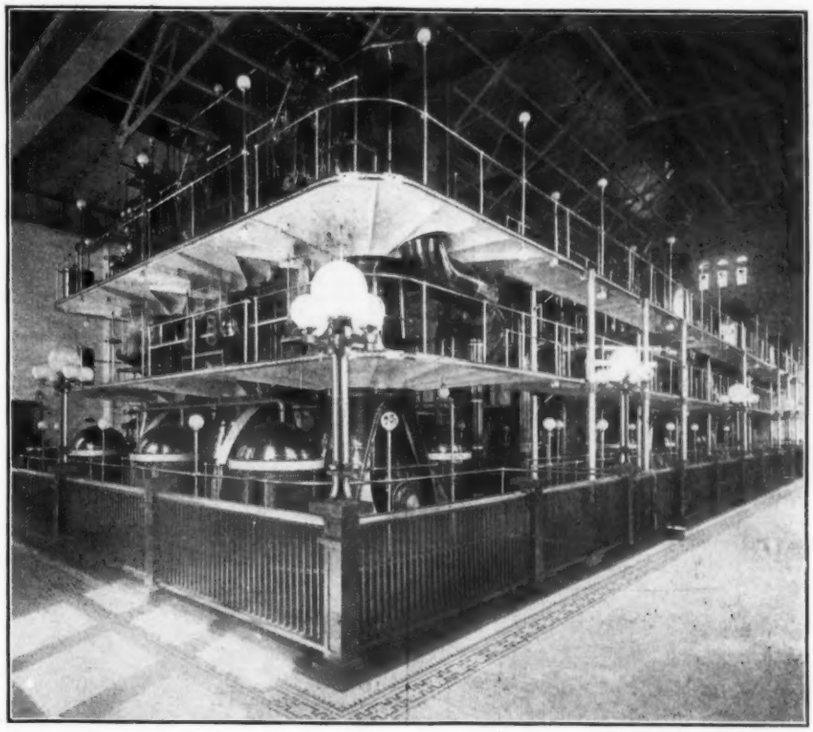


FIG. 6. HANDSOME PUMP ROOM AT LAKEVIEW STATION

TABLE 2. EQUIPMENT COST IN LAKE VIEW STATION

Three vertical triplex pumping engines Five boiler-feed pumps One air compressor Two 75-kw. turbo-generators Duplex station discharge piping and valves	$274,050
One vertical triplex pumping engine	89,900
Five 320-hp. boilers One independently fired superheater Automatic chain-grate stokers Breeching uptakes	73,075
One 6-ft. 6-in. by 200-ft. radial-brick chimney	10,051
Steam and water piping	29,848
Coal-handling equipment	25,970
Two 1,000-hp. open feed-water heaters	1,188
One 500-gal. turbo-generator service pump	1,595
Elevator	1 537
Sump pumps	1,779
Total	$518,993

Each of the three pump plungers works in a separate barrel placed between two pump bodies. As each pump body contains one suction and one discharge valve, there is a total of four for each plunger, or 12 valves per pump, to handle the 25,000,000 gal. per 24 hr.

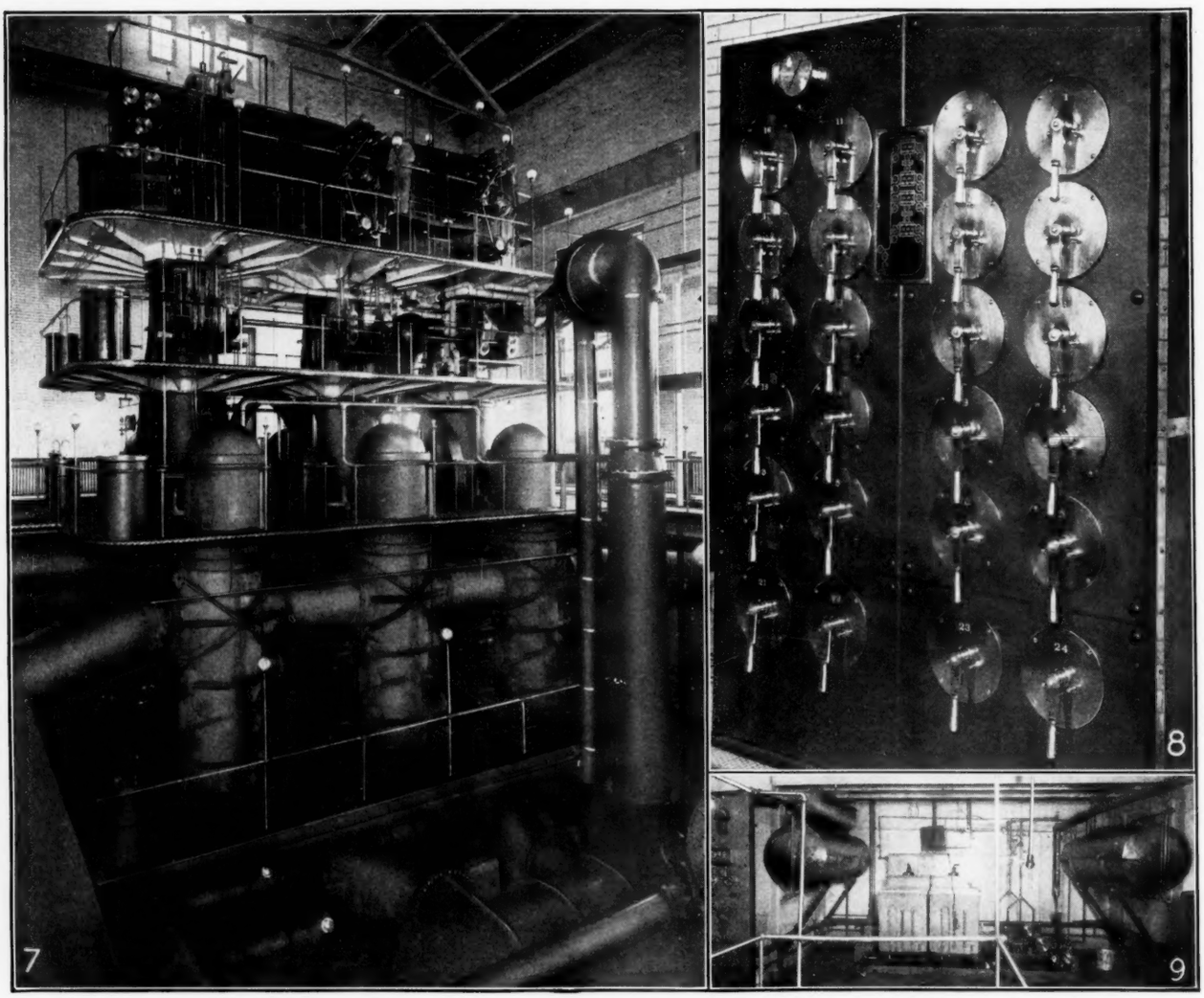
Water from the Lake View crib is conducted through a 6-ft. tunnel at a depth of 64 ft. to a 10-ft. gage shaft dividing into two 5-ft. branches leading to the suction wells. All the water passes up through the condenser on its way to the suction chambers of the pump. There are parallel discharge mains one on each side of the pumproom. Each pump connects to each main independently, so that if one main is down for repairs, the other may be used. In a vault outside the pumproom there is a cross-connection between the mains.

Each pump has one 42-in. suction valve and four 30-in. gate valves on the discharge, making five valves per pump, or 20 for the four units. On the discharge mains and the crossover in the vault there are four additional valves. All are hydraulically operated, the control being centralized on a valve board on the main gallery of the engine room. For each valve there is a special four-way cock, the connections between being two 1-in. galvanized pipes. Supply and waste connections to the control board are provided, so that it is possible to operate any one of the 24 valves from this board.

On the steam end some of the features are special reheating coils between the cylinders, a primary heater in the exhaust main leading to the condenser, swinging doors on the latter supported by a curved rail, a balanced throttle provided with a pilot valve, steam separators placed underneath the lagging, and a combined pressure and speed governor. The pressure feature, however, which provides for control by the pressure in the water mains, has not been utilized.

The units are unusually clear of small piping common to pumping engines of this type. These pipes were concealed in the support to the large oil separator and horizontal run of exhaust piping. The support is an 8-in. pipe neatly lagged with planished steel to a diameter of 14 in., the intervening space between the lagging and the pipe being used as a conduit for all of the smaller piping leading to the top of the unit.

A central system to supply oil to the four main pumping engines, four hotwell pumps, four air pumps, the five boiler-feed pumps, the air compressor and the two turbo-generator lighting sets has been installed. It is an unusually complete system, and provision has been made to handle both machine and cylinder oil. On each pumping engine alone there are 60 points of lubrication. All eccentrics and crossheads are lubricated by telescopic oilers, those on the crossheads being the largest ever built, having a stroke of 6 ft.



FIGS. 7 TO 9. ONE OF THE MAIN PUMPS AND CONTROL AND FILTERING APPARATUS

Fig. 7—One of the 25,000,000-gal. pumps. Fig. 8—Hydraulic control board. Fig. 9—Oil filters and pumps

In the basement there are two receiving tanks, one for machine oil and the other for cylinder oil. The oil barrels are delivered on a truck to the location of the supply tanks where a small electric lift with a suitable crawl and runway has been provided for convenient handling. By a motor-driven plunger pump the contents of the 320-gal. oil-receiving tank is transferred to a 200-gal. gravity tank near the ceiling of the boiler room. From here the oil flows to the various points of lubrication and returns to a pair of 400-gal. oil filters, from which it is again pumped to the gravity tank. The delivery end of the system is duplicated for cylinder oil, and the pumps are so cross-connected that each may be used for either service. A marble switchboard panel has been provided with an alarm bell and annunciators for five high- and low-level alarms having connection with the various tanks and the filter. The bell calls the attention of the station operator, and the annunciators locate the trouble. The panel also contains the switches and starters for the motors driving the oil pumps.

No official test has been conducted, but from the results obtained at Chicago Ave. it is expected that the duty per 1,000 lb. of steam in the new station will approximate 200,000,000 ft.-lb., especially as some improvements that tend toward higher economy have been made in the design of the pumping engines.

Exclusive of grounds and building, the principal equipment in the plant cost $518,993, or $5,190 per million gallons of pumpage capacity. The various items supplied by any one maker are grouped in Table 2. An outstanding figure is the price of the pumping engine last furnished, the cost being $89,900, or $3,596 per million gallons capacity.

Does Technical Writing Pay?

The necessary qualifications for successful free-lance technical writing are, according to F. B. Jacobs in the *American Machinist:* First, an ordinary knowledge of grammar and rhetoric as taught in our public schools. Second, the ability to weave ordinary everyday facts into a smooth-reading article. Third, the knack of composing rapidly, without having to write and rewrite with the object of getting the article to read correctly. (This rule holds good whether one uses the typewriter or the pen.) Fourth, and most important of all, a broad training in mechanical lines, otherwise one would soon find his stock of knowledge exhausted.

While editors primarily are after ideas, they naturally look with favor upon contributions that do not contain a a superfluity of incorrect expressions and vulgar colloquialisms. Therefore it is wise for the aspirant who has a burning desire to break into print—and stay there—to learn to use fairly correct English. The ability to turn ordinary facts into a readable article comes naturally to a few persons, but with the majority this talent has to be acquired. We all know what we want to say, or at least we think we do, but many of us experience difficulty in putting our thoughts down on paper.

A well-written technical article is always devoid of high-sounding expressions or meaningless phrases. Every sentence is written for the purpose of conveying information in ordinary everyday English that is easily understood by the average person. The average person can acquire the ability to turn out acceptable copy if he possesses enough perseverance to tide him over the dark days of his early efforts, when rejected manuscripts are more frequent than editors' checks. Editors have many reasons for rejecting articles, but when an author's efforts are invariably returned, after being examined by several editors, the fault is with the writer, not the editor. A remedy for this state of affairs is to study the work of successful authors, noting their style and the manner in which they handle their subjects.

All copy for technical publications is edited before it goes to the compositor for two reasons: First, to eliminate mistakes in grammar, etc., and second to make the copy conform to the style sheet of the particular paper that is handling the article.

From my own experience, says Mr. Jacobs, I am convinced that technical writing pays The remuneration, of course, is set by the law of supply and demand, as there is a market price for manuscripts as for everything else. It must be borne in mind that there is competition in writing as well as in other lines of effort. Thus it is necessary to acquire the habit of writing rapidly and correctly, otherwise valuable time is sure to be wasted. Eliminating the monetary point of view, technical writing offers other advantages. It trains one to think decisively, which is a great help to the man who desires to rise in his calling, whatever it may be. The man who cannot think in constructive lines is sure to remain in a rut, whereas the individual who trains his mind is fitting himself to take advantage of the innumerable opportunities that present themselves from time to time.

Who Am I?

I am more powerful than the combined armies of the world.

I have destroyed more men than all the wars of the world.

I am more deadly than bullets, and I have wrecked more homes than the mightiest of siege guns.

I steal in the United States alone over $300,000,000 each year.

I spare no one, and find my victims among the rich and poor alike; the young and the old; the strong and the weak; widows and orphans know me.

I loom up to such proportions that I cast my shadow over every field of labor from the turning of the grindstone to the moving of every train.

I massacre thousands upon thousands of wage earners in a year.

I lurk in unseen places and do most of my work silently. You are warned against me, but you heed not.

I am relentless. I am everywhere; in the home, on the street, in the factory, at railroad crossings, and on the sea.

I bring sickness, degradation and death, and yet few seek to avoid me.

I destroy, crush or maim; I give nothing but take all.

I am your worst enemy.

I AM CARELESSNESS.

—*Pacific Service Magazine.*

Acidity of Lubricating Oils—It is necessary for oil to be as free from acid as possible, and to determine whether it is or not the oil should be placed in a glass vessel and a small quantity of copper oxide added. Should there be acid present, the oil will change to green or blue; if not, no change will take place. Litmus paper can be used for the same test, as it turns red when there is the slightest trace of acid.

Testing Absorption Plants

By Julian C. Smallwood*

SYNOPSIS—Methods of determining steam and ammonia quantities, horsepower of pump, concentration and density of ammonia, quantities of weak and strong aqua and anhydrous circulated per minute, etc.

In some respects the results from and methods for the test of an absorption plant are identical to those applying to the compression system, described in the Sept. 19 issue of *Power*. The capacity in terms of ice-melting effect may be found in the same way, and the investigation of the condenser operation is the same. The actual coefficient of performance may not readily be obtained, since the energy imparted to the ammonia (barring the work of the ammonia pump, which is comparatively small) is in the form of heat instead of compressor work. But the ideal coefficient of performance may be determined as for a compression plant and may be useful for purposes of comparison of the two systems.

The principal economy result is the steam consumption expressed in pounds of steam per hour per ton of refrigerating effect. This may be determined *in toto* for the plant or itemized as live steam to the pump and steam to the generator, the latter being subdivided into live and exhaust steam according to whether the one or the other or a combination is used. Under favorable circumstances the generator will use 30 lb. of steam per hour per ton. The steam consumption of ammonia pumps is subject to wide variations due to their construction. Although the energy delivered is small compared with the heat transferred in the generator, a test of this pump should be included in economy trials because of the bearing of its performance on the steam consumption of the plant; and the pump test should preferably include a determination of the horsepower delivered.

Condition and Amount of Ammonia

In addition to these results it is desirable to ascertain the condition of the aqua ammonia and, if convenient, the amount of anhydrous circulated per unit of time. The former is expressed in terms of its concentration; that is, the part of a pound of ammonia in one pound of the aqua ammonia (more frequently expressed as a percentage). The concentration results show the working of the absorber and generator and enable calculations regarding the ammonia circulation.

The steam consumed by the generator is readily ascertained by piping the generator-trap discharge into a weighing barrel. The barrel, to start with, should be about half full of cold water to prevent evaporation of the condensate from the trap. Quick emptying should be provided for. Weights should be recorded at uniform time intervals (to show uniformity of operation), from which data the rate in pounds per hour may be had.

Quality determinations of the steam are important, unless an efficient separator is installed to remove the moisture from the incoming steam, to the consideration of the results, as also are pressure readings.

If reduced live steam is used in addition to exhaust and it is sought to measure them separately, a steam meter may be applied to the live-steam line. The exhaust-steam quantity then equals the total trap condensate minus the meter reading. Measurement of the feed water, as for a boiler test, may also be resorted to, in cases where the plant may be isolated.

When conditions are not favorable to the separate determination of the steam quantities, the steam required to drive the pump may be estimated from the manufacturer's figures for its water rates and from the horsepower actually delivered. These remarks of course apply to steam pumps; where power pumps are installed, the energy may be considered in the list of costs.

Net Horsepower Important

Now as to the energy delivered by the ammonia pump, it is preferable to find the net horsepower output rather than the indicated horsepower. From the data required for the net horsepower and from the number of pump displacements, the slip may be calculated as in ordinary pumping-engine trials.

The required formula for horsepower is

$$\textit{Net horsepower} = \frac{144(P_1 - P_2)V}{33{,}000}$$

in which P_1 and P_2 are the gage pressures worked against in pounds per square inch (that is, of the generator and absorber, respectively) and V is the number of cubic feet of strong aqua circulated per minute.

The quantity of strong aqua V may be determined in several ways. A specially calibrated meter may be used on the discharge side of the pump; the aqua may be measured in calibrated tanks on the suction side; or it may be calculated from the amount of anhydrous circulating or from the quantity of weak aqua, the concentrations being known.

When a receiver is installed to supply the ammonia pump, it may be readily calibrated so that the volume contained, corresponding to any height of the liquid in the gage-glass, is known. Now, by cutting off the flow from the absorber into this receiver for a short interval, the rate, in cubic feet per minute, at which the strong aqua is pumped out, may be ascertained. If desired, two receivers may be arranged in parallel, thereby enabling continuous measurement.

If either the anhydrous or weak aqua is measured instead of the strong aqua, the latter may be calculated from the following relations:

$$A_s = \frac{1 - C_w}{C_s - C_w} \times A$$

$$A_s = \frac{1 - C_w}{1 - C_s} \times A_w$$

in which A_s, A_w and A are the weights in pounds per minute of the strong and weak aqua and anhydrous respectively, and C_s and C_w are the concentrations of the strong and weak aqua respectively, in pounds of NH_3 per pound of solution.

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It is to be noted that, since these relations are between weights, a knowledge of densities is necessary to convert them into volumes. For the aqua this involves a measurement of specific gravity; for the anhydrous the ammonia tables may be referred to. The accompanying chart gives values of the density of aqua corresponding to those of specific heat.

As an example of how these relations are to be applied, let us suppose that the concentrations of the strong and weak aqua are 38 and 26 per cent. respectively (the method of determining concentration will be described later), and that the number of pounds of anhydrous circulated per minute is 20. Then

$$A_s = \frac{1 - 0.26}{0.38 - 0.26} \times 20 = 123 \; lb. \; per \; min.$$

Referring to the chart, it is seen that 38 per cent. aqua has a specific gravity of 0.873, if the aqua is at 60 deg. F., and a density of 54.4 lb. per cu.ft. If the temperature of the aqua at the pump is not much higher than this, then the cubic feet discharged per minute is 123 ÷ 54.4 = 2.26, which is the value of V to be used in the formula for horsepower.

The concentration of aqua ammonia is determinable from its specific gravity. Given a definite solution of ammonia in water, its specific gravity is fixed at any one temperature, say 60 deg. At any higher temperature the solution occupies more volume, owing to expansion, and therefore has a lower specific gravity, although the concentration remains the same. Or to put it another way, for any value of the specific gravity the concentration depends on the temperature.

Because of the volatility of aqua ammonia at the high temperature, and reduced pressure prevailing when a sample is drawn, considerable care must be taken when testing for concentration. The following procedure is recommended. Outlets for samples of the aqua are arranged at points where the temperatures are comparatively low; that is, on the discharge side of the pump for the strong aqua and between the absorber and weak-aqua cooler for the weak. These outlets should be fitted with short lengths of rubber tubing. A glass graduate, reading preferably in cubic centimeters, is provided, together with a hydrometer or a sensitive scales. The graduate is about half filled with water for the first trial (for the second, a somewhat different amount may be selected, depending upon the outcome of the first) and then placed in a bucket of cold brine until it and its contents are chilled to about 32 deg. After running a little aqua through the sampling tube, it is directed below the surface of the water in the graduate until the mixture of cold water and incoming aqua attains a temperature of about 60 deg. as shown by a thermometer. The specific gravity of the mixture should now be taken quickly with a hydrometer or by weighing the contents of the graduate and then by calculation. Provided the temperature is within 5 to 10 deg. of 60 deg., the concentration of the mixture may now be found on the chart against the determined value of its specific gravity. It is the concentration of the sample that is sought, however, and this may be calculated from the following relation:

$$Conc. \; of \; sample = conc. \; of \; mixture \div \left(1 - \frac{R}{S_m}\right)$$

in which R is the ratio of the volume of cold water, before mixing with the sample, to the volume of the mixture, and S_m is let represent the specific gravity of the mixture.

If scales instead of hydrometer are used to obtain the weights of cold water and mixture, then the concentration of the sample is more readily figured from the relation

$$Conc. \; of \; sample = conc. \; of \; mixture \times \frac{weight \; of \; mixture}{weight \; of \; sample}$$

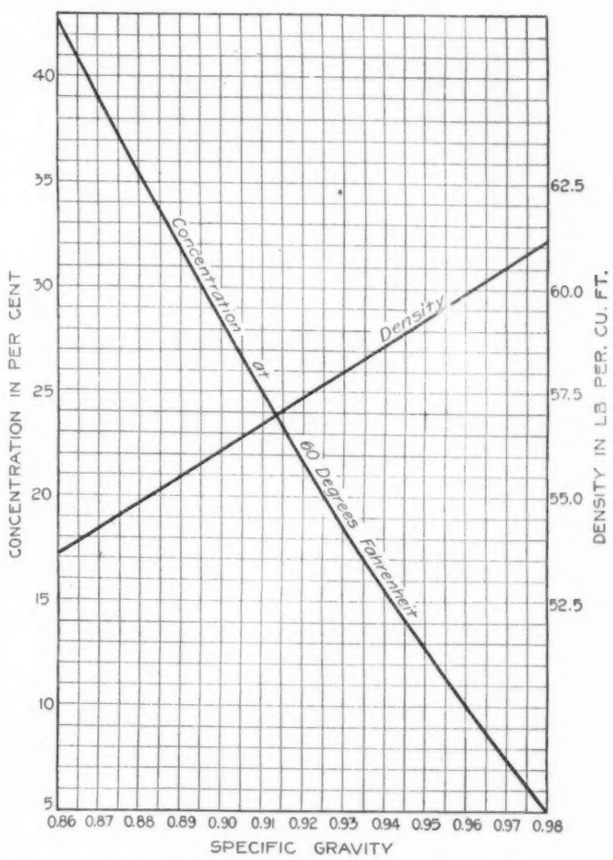
If the temperature of aqua ammonia is higher than 60 deg., its specific gravity will be lower by between 0.001 and 0.005 for each 10 deg., depending upon the concentration, the stronger solutions having a higher coefficient of expansion and therefore needing greater correction than the weaker. Under these circumstances the specific gravity S_{60} of a given solution at 60 deg. can be figured from its specific gravity S_t at t deg., the following formula, which gives moderately accurate results, being used[1]:

$$S_{60} = S_t + 0.003(t - 60)(1 - S_t)$$

For example, if the specific gravity is found to be 0.865 at 75 deg., then at 60 deg. it equals

$$S_{60} = 0.865 + 0.003(75 - 60) \; (1 - 0.865) = 0.871$$

The value 0.871 is then to be referred to the chart for the corresponding concentration.



CONCENTRATION OF AQUA AMMONIA AT 60 DEG. F., AND DENSITY VARIATION

[1]Curves presented in Marks' Mechanical Engineers' Handbook may also be used

When the reverse calculation is sought (for the density determination of aqua at high temperatures) this formula may be expressed thus:

$$S_t = \frac{S_{60} - 0.003(t - 60)}{1 - 0.003(t - 60)}$$

Turning now to the measurement of the quantity of weak aqua and anhydrous circulated per minute, calculations may be based on the relations previously given, transposed as follows:

$$A_w = \frac{1 - C_s}{1 - C_w} \times A_s$$

$$A = A_s - A_w$$

For direct measurement of these quantities, much the same methods may be employed as for the strong aqua. The reader is reminded that only one of the three quantities, A, A_w or A_s, need be directly measured for a fairly accurate knowledge of the performance of the plant, when the concentrations are known. The ammonia, whether aqua or anhydrous, may therefore be directly metered at a point selected according to the existing layout. It should be borne in mind, however, that the results depending upon concentration figures may not be exact, because of the difficulty in getting close values of the concentrations.

If the anhydrous is measured by volume, a temperature or pressure reading also should be obtained to find the density of the liquid from the tables of properties of ammonia. When closely accurate results on the anhydrous quantity rate are desired, a favorite method is by direct weighing. Two ammonia drums, arranged in parallel, are piped in the line between the condenser and expansion valve, so that they can be filled and emptied alternately. These drums are set on platform scales, the connections to them being horizontal and sufficiently long to deflect about ¼ in. under a load at the end of about ¼ lb. The drums and contents may then be weighed without sensible error. The increase of accuracy of this procedure probably does not justify the elaboration of the apparatus.

It is useful to find the number of pounds of anhydrous per minute per ton of refrigerating effect and to compare this with the amount theoretically required as tabulated in handbooks or calculated from heat contents under prevailing conditions.

In conclusion it may be observed that the choice of means to find both the steam and ammonia quantities of an absorption must be governed by the layout of the plant and the degree of accuracy desired.

University of Toronto Central Heating and Power Plant

By L. M. Arkley*

The central power plant of the University of Toronto was installed in 1911-12 for the purpose of supplying light and heat to the widely scattered buildings of the University (see Fig. 1), previously heated by several small plants, most of which were old and inefficient. A part of the current for light and power was generated in these plants, and the remainder was bought from power companies. Such conditions, it seemed, should warrant the installation of a central plant so as to cut down the cost, and the results appear to justify the conclusion.

The boiler room contains four 400 and one 515 rated hp. boilers (a total of 2,115 hp.) equipped with Murphy gravity-fed furnaces and operated at 150 lb. pressure, no superheat.

The coal used is a bituminous slack, containing about 21 per cent. volatile matter, and is burned with very little smoke. While it is not bought on the B.t.u. basis, samples are taken regularly from the delivery wagons and tested for ash, volatile matter, carbon, moisture and sulphur. The records show that the quality of the coal received is uniformly high.

The engine room is adjacent to the boiler room and contains one 300-kw. turbine-driven generator, one 100-kw. and one 50-kw. generator each driven by a single-

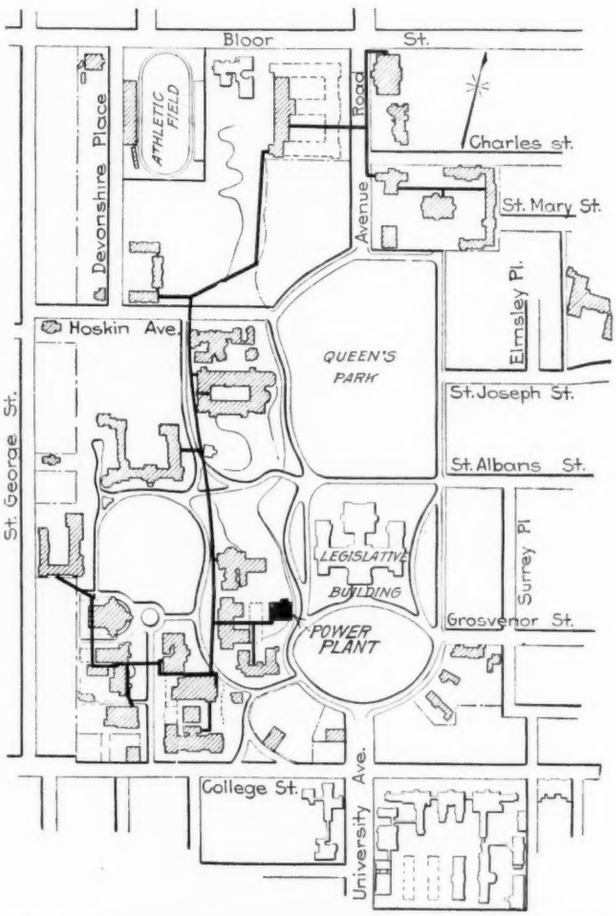


FIG. 1. GENERAL LAYOUT OF BUILDINGS AND GROUNDS

cylinder vertical engine and one 300-kw. generator driven by a vertical compound engine.

The heating system was originally a gravity return to the hotwell in the power house, that being the low point, but the Main and Mining buildings have been changed to a vacuum system and the same method has been adopted for two other buildings recently completed. The vacuum pumps located in these buildings discharge the returns from the radiation to overhead tanks, from which the condensate flows by gravity into the main return line to the power house.

There are in all twenty-one buildings containing a total of 196,534 sq.ft. of radiation served from this one central

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plant. The route of the connecting tunnel is shown by the heavy line in Fig. 1, and Fig. 2 is a section of the tunnel.

All engines and pumps exhaust into a 20-in. heating main, but the electric load is small compared with the heat required, so live steam is introduced through a reducing valve at a pressure of 1 to 4 lb.

Line expansion and contraction due to changes in temperature are taken care of by slip expansion joints, the pipe being securely anchored at certain points. These joints give good satisfaction if the pipe is kept well in line, otherwise they leak.

A question of great importance is that of condensation, as excessive condensation not only means a loss of heat, but introduces the problem of taking care of the water. This feature in the original layout was somewhat neglected, resulting in a hot tunnel and large quantities of condensate in the main pipe. This was drained from the pipe through traps to the power house, but it was found necessary later to put a vacuum pump on the end of this return line in the power house. With this addition the system works satisfactorily. Besides the main heating

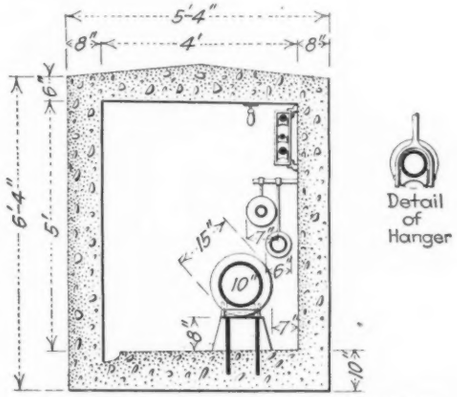


FIG. 2. SECTION OF THE NEW TUNNEL

pipe the tunnel contains a 5-in. live-steam main, the 8-in. gravity return line and a 5-in. return line to the vacuum pump. The live steam is carried at 50 lb. pressure and is used principally for cooking purposes. In addition to these pipes all electric wires are carried on the walls of the tunnel.

The main tunnel is of concrete, 5x6 ft. inside where it leaves the power house, and its walls are 8 in. thick, while the roof reduces in thickness from 9 in. at the center to 6 in. at the walls, and is reinforced where deemed necessary.

A test made to find the efficiency of the plant under actual working conditions gave the results shown in the following tables:

CAPACITY AND ECONOMY

Boiler horsepower developed (average)	1,592
Rated capacity per hour (10 sq.ft. H.S. per boiler horsepower)	2,125
Percentage of rated horsepower developed	75
Water fed per pound of coal as fired	9.12
Water evaporated per pound of dry coal	9.31
Equivalent evaporation from and at 212 deg. per lb. of coal as fired	9.78
Equivalent evaporation from and at 212 deg. per lb. of dry coal	10.14
Equivalent evaporation from and at 212 deg. per lb. of combustible	11.14

EFFICIENCY

Calorific value of 1 lb. of dry coal by calorimeter, B.t.u.	14,800
Calorific value of 1 lb. of combustible by calorimeter, B.t.u.	15,800
Efficiency of boiler furnace and grate, per cent	66.5
Efficiency based on combustible, per cent	68.3

COST OF EVAPORATION

Cost of coal per ton of 2,000 lb. delivered in boiler room	$3.525
Cost of coal required for the evaporation of 1,000 lb. of water under observed conditions	.193
Cost of coal required for evaporating 1,000 lb. of water from and at 212 deg. F	.1802

The following tables show the temperatures reached in the different months of the winters of 1912-13, 1913-14, 1914-15, and the cost of heating per square foot of radiation during these years:

TEMPERATURES AND COAL USED

	Average Daily Temp., 1912-13, Deg.	Coal, 1912-13, Tons	Average Daily Temp., 1913-14, Deg.	Coal, 1913-14, Tons	Average Daily Temp., 1914-15, Deg.	Coal, 1914-15, Tons
October	50.6	17.0	51.6	14.2	52.75	13.2
November	40.5	36.5	42.4	31.4	38.13	29.1
December	32.6	49.0	33.4	35.7	25.72	41.5
January	31.3	43.8	25.5	46.0	23.62	44.5
February	20.4	58.2	15.5	57.4	26.04	44.9
March	33.3	42.8	30.8	37.6	29.93	38.6
April	46.3	23.6	41.5	24.2	49.82	18.6
May	54.3	10.1	58.5	10.1	52.15	7.0

DATA ON THE COST OF OPERATION

	1912-13 Total Cost	1912-13 Cost per Sq.Ft. Radiation, Cents	1913-14 Total Cost	1913-14 Cost per Sq.Ft. Radiation, Cents	1914-15 Total Cost	1914-15 Cost per Sq.Ft. Radiation, Cents
Cost of coal	$29,429.52	17.23	$26,649.23	15.12	$25,135.64	12.80
Cost of city water	510 62	0.30	265.90	0 15	209.00	0.11
Repairs and renewals	2,393.39	1.41	3,674.89	2.08	5,354.06	2.73
Salaries (engineers, firemen, helpers)	8,713.81	5.12	7,992.47	4 54	7,972.25	4.05
Electric current purchased	1,100 66	0.65	1,424.24	0.81	1,329 32	0.66
Total cost of operation	$42,148.00	24.71	$40,006.73	22 70	$40,000.37	20.35
Total sq.ft. radiation	170,221		176,203		196,534	
Total current generated, kw-hr.	395,395		351,231		390,655	
Total water evaporated, lb.	112,329,664		121,657,911		117,424,163	
Total cost of coal required for evaporating 1,000 lb. of water under observed conditions, cents	26.2		21.9		21.4	
Cost of evaporation per 1,000 lb. steam, cents	38		33		34	

The increased charge on repairs and renewals is accounted for by extensive alterations which have ultimately reduced the cost of operation. In this distribution of cost no charge is made for light and power or high-pressure service.

Leaky Transformer Cases

By M. A. Walker

Leaks sometimes develop in transformer cases for no apparent reason, although the probable explanation is that strains are set up by temperature changes and mechanical stresses in the transformer resulting from magnetic conditions. Whatever the reason may be, leaks do develop, causing much annoyance. Often the transformer can be taken out of service, oil, core and windings removed and the case treated much as a boiler would be; that is, welded by an oxyacetylene flame or calked. In many instances the high cost and delay incident to removing the core and windings precludes doing so, and the leak must be stopped with the unit assembled, after removing the oil. Again in other circumstances the oil cannot be removed because the unit has to remain in service, and the oil, which acts as an insulating medium, if taken out would probably allow the transformer to break down between coils or turns.

Where the oil cannot be removed, the difficulties in the way of doing a good job are greatly increased. Oil is the enemy of soldering and constitutes a fire risk because of its inflammable qualities. Therefore the use of an open flame is something that is not to be encouraged around transformer oil.

Sometimes a fairly good job can be done by cleaning the surfaces thoroughly with strong acid and soldering. The odds are against this, however, because the oil oozes through the leak, while the high heat conductivity of the oil and case prevents the local area from being heated sufficiently to make a good job. Besides, the element of risk is always present. This method is not to be recommended, on the score of danger and the poor results to be looked for.

Another method that serves as a temporary measure consists of placing a cement of soft carbonate of lime in the seams or leak and covering this with a coating of shellac or iron-oxide paint. This course is applicable only to those cases where there is sufficient space in the crevices or interstices of the leak to permit the cement to adhere. At most it is only a temporary measure.

Perhaps the most satisfactory manner in which to stop a leak, where the location permits, is to plug it up. A hole is drilled in the case at the place where the leak exists, and tapped. A plug is then smeared with shellac and screwed into it. This method is quite satisfactory provided there is enough thickness in the case for a thread to hold. Of course, where the leak is in the bottom and underneath, and cannot be got at, nothing remains but to raise the transformer, and this means taking it out of service. When a transformer case is found to leak, it should be repaired as soon as possible, because the oil will soak into the floor, causing the collection of dirt and dust.

Practical Talks on Controllers--Counter-E.M.F. Type

SYNOPSIS—The second article in the series on controllers for electric motors. The effects of the starting resistance in the armature circuit of a direct-current motor are explained and how the counter electromotive force developed in the armature may be used as a means to obtain automatic acceleration.

Unlike a coil of wire in which the current is limited by the resistance of the circuit, the current in the armature of a direct-current motor is limited almost entirely by the counter electromotive force generated in the conductors. When the motor is running, the counter e.m.f. generated in the armature is almost equal to the applied voltage; at standstill it is zero. The resistance of the armature is low, therefore a resistance must be connected in series with it at starting to limit the current to a safe value.

The resistance connected in series with the armature is usually of a value that will limit the starting current to about 125 per cent. of that at full load. That is, if the full-load current of a motor is 20 amp., the starting resistance will be of such a value as to limit the armature current to $20 \times 1.25 = 25$ amp. When the armature starts to revolve, a counter e.m.f. is generated and the current is reduced until the machine reaches a certain speed, which will be fixed by the load. At this point, if a section of the resistance is cut out, the current will be again increased, and this will raise the speed of the armature, causing the counter e.m.f. to increase, and decrease the current to a value fixed by the load on the motor.

Just what takes place when the motor is starting will probably be better understood by an example: Assume a condition as shown in Fig. 1; the armature resistance $R_1 = 0.5$ ohm, and the starting resistance $R_2 = 8.5$ ohms, a total resistance of $0.5 + 8.5 = 9$ ohms. With 225 volts impressed on the circuit at the instant of closing the switch the current I that will flow in the circuit will equal the effective voltage E_e divided by the ohmic resistance R. That is, $I = \frac{E_e}{R} = \frac{225}{9} = 25$ amp. Note that the effective voltage is the difference between the line volts and the counter e.m.f. When the motor is standing still, the counter e.m.f. is zero, consequently the total line e.m.f. is effective.

The pressure E_1 across the motor terminals will equal the armature resistance R_1 times the total current I. Hence $E_1 = R_1 I = 0.5 \times 25 = 12.5$ volts, as shown. The difference between the line pressure E and E_1 is used up across the resistance, or $E_2 = E - E_1 = 225 - 12.5 = 212.5$ volts. E_2 is also equal to the starting resistance R_2 times the current I; that is, $E_2 = R_2 I = 8.5 \times 25 = 212.5$ volts in either case.

As the motor speeds up, a back pressure (counter e.m.f.) is generated in the armature, which decreases the current. Assume that the motor attains a speed that will cause a counter e.m.f. e of 90 volts to be generated in the armature. The effective pressure E_e will equal the line volts E minus the back pressure e, or $225 - 90 = 135$ volts. The current I_1, flowing through the armature under this condition equals the line voltage E minus the counter e.m.f. e divided by the total resistance R, or $I_1 = \frac{E - e}{R} = \frac{225 - 90}{9} = 15$ amp., as indicated in Fig. 2.

The volts drop E_2 across the starting resistance is now equal to the product of the starting resistance R_2 and the current I_1; that is, $E_2 = R_2 I_1 = 8.5 \times 15 = 127.5$ volts, which leaves $E_1 = E - E_2 = 225 - 127.5 = 97.5$ volts across the armature. The volt drop across the armature due to resistance is equal to the armature resistance R_1 times the current I_1 equals $0.5 \times 15 = 7.5$ volts. It will now be seen that this value (7.5 volts) plus the assumed counter e.m.f. (90 volts) equals 97.5 volts, the new value calculated for the drop across the armature, as shown in the figure.

From the foregoing it will be seen that as the motor speeds up the current decreases and the pressure increases across the armature terminals. This continues to a point where the machine is just taking current enough from the line to carry the load, or, as assumed in this case, 15 amp. Any further increase in speed would be followed by a further increase in the counter e.m.f. and a decrease in the current. If the motor was starting under no load, it would run up to about full speed and the volts drop across the armature would be almost equal to the line pressure. On moving the starting-box arm upon the second point, the resistance

will be reduced, say to 6 ohms, as shown in Fig. 3; now the ohmic resistance of the circuit equals 6 + 0.5 = 6.5 ohms. When the arm was moved upon the second point of the starting resistance, the effective pressure equaled 135 volts; therefore, at this instant the current will increase to $I_2 = \frac{E_e}{R} = \frac{135}{6.5} = 20.77$ amp. approx.

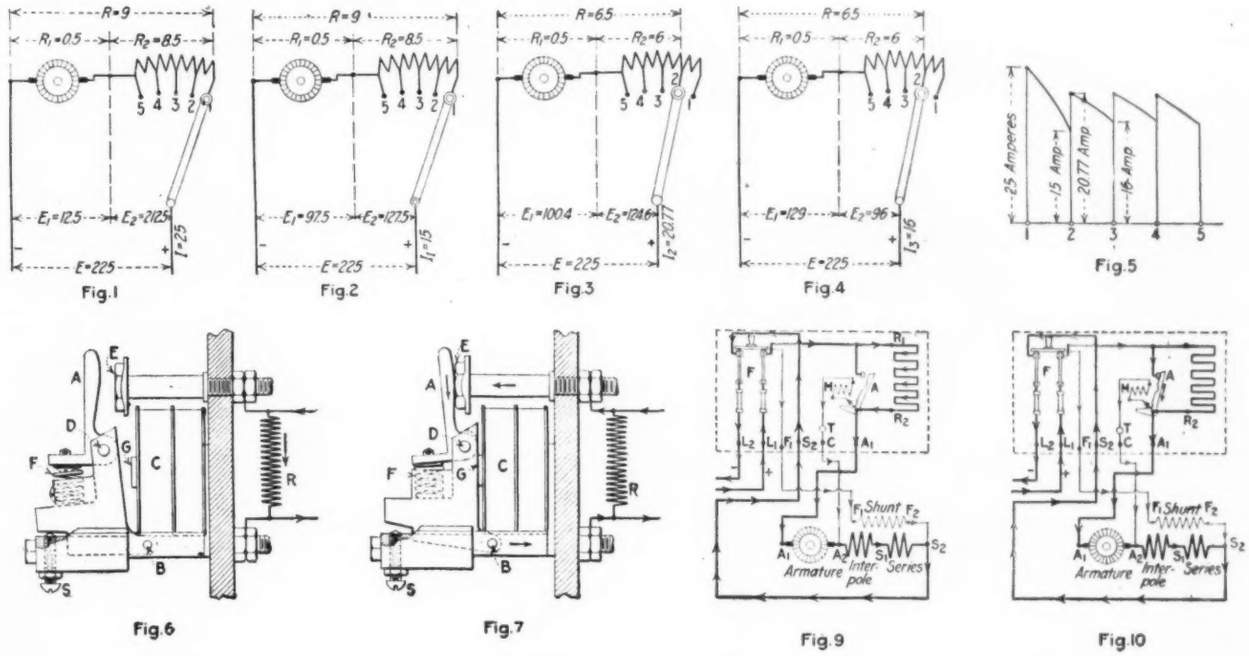
Under the new condition the voltage drop across the starting resistance will be $E_2 = R_2 I_2 = 6 \times 20.77 = 124.6$ volts, and the drop across the armature due to the resistance equals $R_1 I_2 = 0.5 \times 20.77 = 10.4$ volts. The total voltage impressed on the armature equals that due to resistance plus the counter e.m.f., or in this case 10.4 + 90 = 100.4 volts. The values are shown on the figure and total up to the line volts, which is as it should be.

This increase of potential and current to the armature will cause an increase in the speed, which in turn will raise the counter e.m.f. and again decrease the current to a value where the torque will be just sufficient to carry the load. Assume that the current decreases to I_3 = 16 amp. Then the volts drop across the resistance will equal $R_2 I_3 = 6 \times 16 = 96$ volts, and the drop across the armature will be the difference between this and the line voltage, or 225 — 96 = 129 volts, as shown in Fig. 4. The resistance of the armature will cause a drop of $R_1 I_3 = 0.5 \times 16 = 8$ volts, and the difference between this and the total drop equals the counter e.m.f., or 129 — 8 = 121 volts.

The foregoing shows how the starting resistance limits the current to the armature and how the e.m.f. gradually increases at the motor terminal as the speed increases. When the starting resistance is all cut out, full line pressure will be applied to the armature terminal, the motor will come up to full speed, and the counter e.m.f. will be almost equal to the line volts. The difference will equal the armature resistence times the current.

If points are taken on a straight line, as in Fig. 5, to represent the points on the starting box, and at these points vertical lines are drawn to represent the amperes to scale, a curve may be obtained that will represent the starting current. For example, when the starting-box arm was placed on the first point, the current rose to 25 amp., as shown by the vertical line drawn from point 1. As the motor increased in speed, the current decreased to 15 amp. before the starting-rheostat arm was placed on point 2. This is shown by the decrease in current curve between 1 and 2. At the instant of closing the circuit on point 2, the current increased to 20.77 amp., also indicated on the vertical at point 2 in the figure. This rise in current caused a further increase in speed, and the current decreases to 16 amp., as indicated on the vertical at point 3. When the arm is moved on point 3, the resistance will again be decreased and the current increased, all the time the speed of, and voltage at, the armature terminal is rising, until all the resistance is cut out and full voltage is applied to the armature terminal.

The gradual increase of the voltage across the armature terminal is used in many cases for automatic closing of electromagnetic switches, or as they are usually called, contactors, to cut out the armature resistance and thereby automatically accelerate the motor. A scheme of this kind is known as the counter-electromotive-force type of automatic acceleration. A contactor for this type of controller is shown in Fig. 6. When the coil C is energized to a certain value, the magnetic pull becomes strong enough to close the contactor A, which is hinged at B. The contactor is shown in the closed position in Fig. 7. The contact arm has a joint in it at D, and is held in the forward position by a spring F, and is so adjusted that the contact at E closes before the arm comes in contact with the core of the coil at G, which insures that the circuit will be held closed



FIGS. 1 TO 10. EXPLAIN THE COUNTER-ELECTROMOTIVE-FORCE CONTROLLER

Figs. 1 to 5—Effects of the starting resistance in the armature circuit. Figs. 6 and 7—Automatic contactor. Figs. 9 and 10—Wiring diagrams for a counter-electromotive-force controller

under the tension of a spring. Another feature about this is that a slight rolling contact is obtained on the circuit-closing parts which prevents welding of the contact on the first inrushes of the current. The resistance is not actually cut out of the circuit, but short-circuited. It will be seen in Fig. 6 that the current must flow through the resistance R, but in Fig. 7 the resistance is short-circuited by the contactor, which creates a path of very low resistance; consequently, the current will no longer flow through the path R, but through the contactor.

The number of contactors used to cut out the starting resistance, or as it is usually referred to, the number of resistance steps or points, depends on the conditions to be met. For 115- to 230-volt motors up to 3 hp. in size, where the starting conditions are not too severe, one step is usually enough. Fig. 8 shows a controller of this type manufactured by the General Electric Co. The wiring diagram for this piece of apparatus, connected to

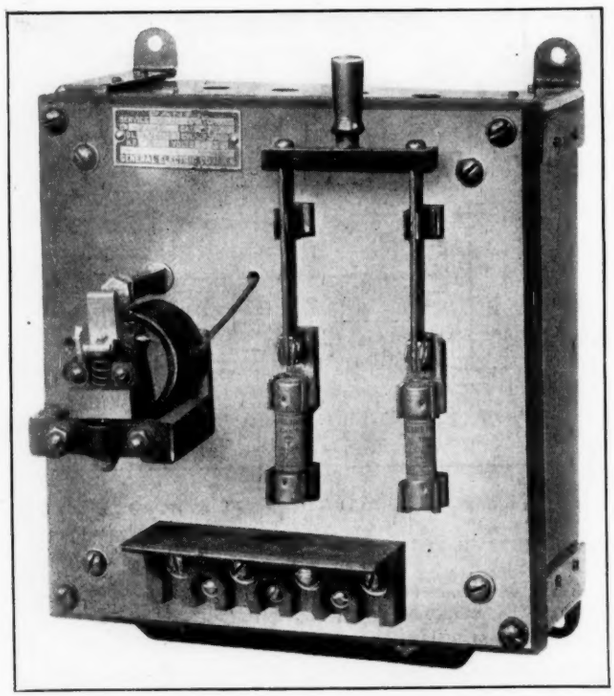


FIG. 8. COUNTER-ELECTROMOTIVE-FORCE TYPE OF AUTOMATIC STARTER

a compound interpole motor, is shown in Fig. 9, the operation being as follows: When the line switch F is closed, current flows from the positive terminal L_1 through the switch, where it divides and flows through two paths, one the fine line through the shunt field to S_2 on the series field, through the heavy conductor to S_2 terminal on the controller, to the opposite side of the switch and back to the negative side of the line, as indicated by the light arrowheads. The other path is through the heavy conductor to the resistance terminal R_1, through the starting resistance to the bottom of contactor A, down to the A_1 terminal on the armature, through the interpole and series-field windings to S_2 terminal of the series field, then through the heavy conductor back to the negative side of the line, as shown by the heavy arrowheads. This completes the motor circuit, which should cause it to start and speed up.

One terminal of the magnet coil M is connected to the bottom of the contactor A, which goes to terminal A_1 of the armature. The other terminal is connected through the resistance T to the other armature terminal A_2. This connects the contactor coil across the armature terminals, therefore current can also flow from the bottom of the contactor through this coil to terminal A_2 on the armature through the interpole and series-field winding to the negative side of the line. The value of the current flowing through the coil will depend on the pressure across the armature terminals.

Assume that 80 volts is required to be impressed on the magnet-coil circuit to make the pull strong enough to close the contactor. If the condition across the armature and starting resistance is the same in Fig. 9 as in Fig. 1 at the instant of closing the line switch, the voltage drop across the armature will be only 12.5 volts. This will not magnetize the coil strongly enough to close the switch, and just as long as the motor stands still this condition will exist. As the motor speeds up, the voltage increases across the armature terminals, as explained in Fig. 2, in which case it was assumed to have increased to 97.5 volts. The magnet coil requires only 80 volts impressed on its terminal to close the contactor. Therefore, when the potential on the armature increases to this value, the coil will close the contactor, which will short-circuit the resistance, as indicated in Fig. 10. The current will still flow through the same circuit as in Fig. 9, except instead of flowing through the starting resistance it will take the easier path, which is through the contactor A; as indicated by the arrowhead. Full potential is now impressed across the motor terminals, and it will come up to full speed.

The controller described in the foregoing paragraphs, being small and its functions simple, will not have the complication of troubles that may occur on the more intricate types of control apparatus. In general even the most intricate of modern controllers cause very little trouble if given intelligent care.

An open circuit in the starting resistance or any part of the armature circuit would prevent the motor from starting. By connecting a test lamp across the contactor switch, as from A to E, Fig. 6, with the line switch closed will indicate if the open is in the resistance or elsewhere in the armature circuit. An open in the resistance will be indicated by the lamp burning brightly, otherwise the open is in some other part of the circuit.

An open in the magnet-coil circuit or an overload on the motor will prevent the contactor from closing. After the motor has attained normal speed with the contactor open, closing it by hand will indicate if the magnet-coil circuit is open or not. If open, the contactor will drop out when not held closed by hand. If the coil circuit is closed, it will remain closed and may only require adjusting.

The adjustment of the contactor is made by turning up or down on the screw S, Figs. 6 and 7. Turning up on the screw throws the contact arm closer to the coil, causing it to close earlier. Backing down on the screw increases the gap between the contact arm and the coil and delays the time of closing.

Small Piston Rods can be removed from the crosshead without scoring by using a Stillson wrench and two hardwood blocks hollowed out to fit the rod and bolted to it by four ½-in. bolts. A piece of sandpaper should be placed between the rod and the blocks, which, when clamped to the rod, have a space between them. The blocks afford a place to put a wrench and turn the rod out of the crosshead.

Two-Speed Alternating-Current Elevator Motors

SYNOPSIS—Until recently, the car speed of elevators driven by alternating-current motors has been limited to 250 ft. per min. on account of a suitable adjustable-speed alternating-current motor not being available. This article describes a two-speed alternating-current motor that has recently been developed for this purpose, making car speeds of 400 ft. per min. possible. The construction and operation of this motor are explained.

The two-speed alternating-current elevator motor shown in Fig. 1 mounted on an elevator machine is designed for operating high-speed elevators. Until recently, the speed of the car for an alternating-current elevator equipment was limited to 200 to 250 ft. per min. owing to the necessity of using a single-speed motor. This limitation of speed was due to the fact that in slowing down for a stop, an alternating-current equipment with a single-speed motor had to be stopped by a mechanical brake. On a direct-current outfit with field control, slow down and dynamic braking are employed. By the use of the two-speed alternating-current motor a car speed of 400 ft. per min. is now possible, and starting and stopping is accomplished as smoothly as with an equipment driven by a direct-current motor.

The unique feature of this two-speed alternating-current motor, which is built by the Westinghouse Electric and Manufacturing Co., is the use of two separate windings in both stator and rotor. Mechanically, the construction of this type of motor is the same as that of the standard single-speed type CI elevator motors made by the same company. Special attention has been paid to securing the quiet operating essential for apartment house, hotel and office building service. The motor develops a high torque at low speed with a starting current only 50 per cent. above the current at full speed with full load.

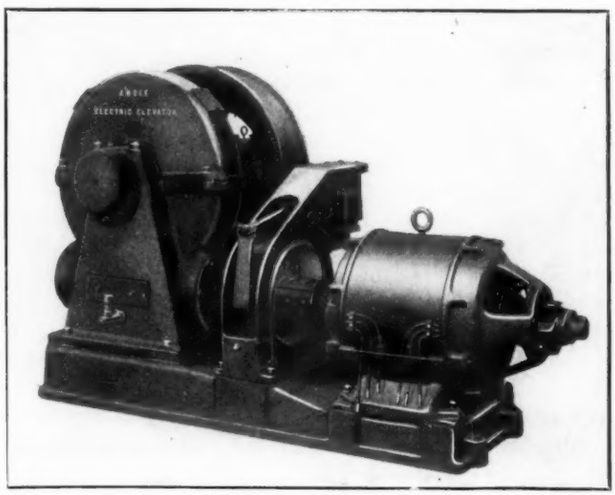


FIG. 1. TWO-SPEED ALTERNATING-CURRENT MOTOR COUPLED TO AN ELEVATOR MACHINE

For starting, a 24-pole connection is used, giving a motor speed of 250 r.p.m. When the motor attains sufficient speed the connections are changed to give 8 poles, and the motor then comes up to a speed of about 850 r.p.m. In slowing down, the 24-pole connection is again employed. At the instant this is done, the motor is running at a higher speed than the synchronous speed for this connection. As an induction motor driven above synchronism acts as a generator, this produces an electrical-braking action that quickly brings the motor speed down to synchronism. Then by disconnecting the motor from the line and applying an electrically operated mechanical brake, the car is easily brought to rest. Both rotor windings are connected to the same slip rings so that only three collector rings are necessary as indicated in Fig. 2. In operation the 8-pole rotor winding responds only when the 8-pole stator connection is made and the 24-pole winding is only active when the stator is connected for 24 poles.

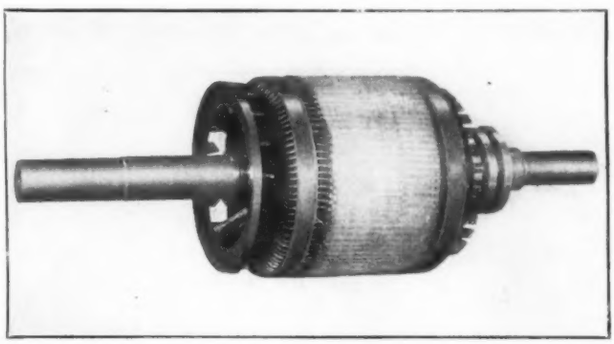


FIG. 2. ROTOR OF TWO-SPEED ALTERNATING-CURRENT MOTOR

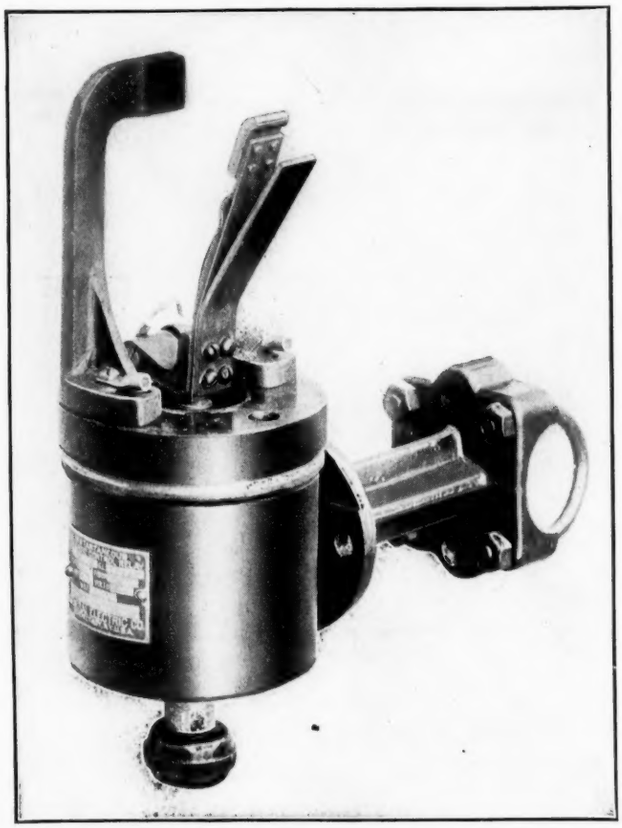
This line of two-speed alternating-current elevator motors permits the use of alternating current for high-speed elevator service, and eliminates the loss in transfomation heretofore necessary, where direct current is not furnished by the central station. The standard sizes of these motors are 25, 30, 35 and 40 hp.

The controller employed consists of a number of magnetically operated switches and relays mounted on a slate panel and operated by a car switch located in the elevator car. When the car switch is thrown to either the full up or down position the controller connects the low-speed motor winding to the line with resistance in the rotor circuit. As the motor accelerates, this resistance is automatically cut out by magnet switches, the rate of operation of which is controlled by series current-limit relays, bringing the motor up to the full speed of the low-speed winding. A change-over switch then closes, opening the low-speed winding and impressing voltage on the high-speed winding with resistance in the rotor circuit. This transition is made so smoothly that it cannot be noticed in the elevator car. The resistance is then cut out automatically as above, bringing the motor and car to full speed. Both acceleration and retardation are accomplished smoothly, without any shock or jar in the car. The car switch

provides for two running speeds in each direction. The same safety devices, such as hatchway and car-limit switches, slack-cable switches and emergency car switch, used with high-speed elevators driven by direct-current motors, can be used with this equipment.

Solenoid Control Relay

Solenoids for operating large carbon-break circuit-breakers or oil switches frequently require comparatively large currents in the closing solenoid. In such cases the contacts of control switches used to control the operation of the solenoid are not suited for this purpose. It then becomes necessary to use a control relay with its operating coil excited by the closing of the control switch and the



INSTANTANEOUS DIRECT-CURRENT CONTROL RELAY

relay contacts in series with the closing solenoid of the circuit-breaker or oil switch. The illustration shows a control relay recently developed by the General Electric Co., Schenectady, N. Y., and consists essentially of a solenoid, plunger and contacts. There is a metallic connection, consisting of a small flexible lead, between the movable contact arm and its support. The contacts are kept clean by a wiping motion each time the relay is operated. The relay can be closed by hand, by an insulated button on the lower end of the plunger.

The Sprengel Vacuum Pump in its simplest form consists of a long, vertical glass tube of narrow bore down which mercury is allowed to flow. The region to be exhausted is connected by an oblique tube at a point some 30 in. above the lower end of the tube. As the mercury streams down the vertical tube, the air passes out of the side tube and connected vessel into the vertical tube, thence down with the mercury stream, escaping at the lower end. The action is somewhat similar to that of a barometric condenser. With a Sprengel pump it is possible to get vacuum whose pressure is only 0.005 of the millionth of an atmosphere.

Ammeter Used as a Wattmeter

By M. A. Walker

An ammeter is always inserted in the main circuit or load side of generating apparatus such as rotary converters, generators, etc., for indicating current. Wattmeters are also inserted in alternating-current machines, as the wattage does not vary proportionally with the current because of varying power factor, whereas with direct-current machines a wattmeter may be omitted. It is, however, often convenient to have the watts as well as the amperes being supplied by a direct-current machine indicated.

In machines such as rotary converters maintaining constant voltage on the bus, the terminal voltage varies little from normal, and it is so nearly constant that it is considered so. Since the kilowatts generated by a direct-current machine are the product of the amperes and volts divided by 1,000, the kilowatt output of a constant-voltage machine will vary with the current. In other words there is only one variable, the current. If now the ammeter reading be multiplied by a constant corresponding to the voltage divided by 1,000, a reading in kilowatts is obtained. The constant to be used will depend upon the voltage of course. For example, a railway rotary maintaining 600 volts at the busbars will have a constant of 600 to convert the ammeter reading into watts, or a constant of 0.6 to convert it into kilowatts. The constant 0.6 is easily remembered and the ammeter readings readily multiplied by it, but where the voltage is 625 or 550 the constants are more difficult to use mentally. In any case, instead of attempting to remember the factor of conversion and having the trouble to use it every time it is desired to convert from amperes to kilowatts, it is far better to have this done once and for all time by making the ammeter a wattmeter also.

To accomplish this all that is necessary is to print on the ammeter scale, underneath or above the calibration, a scale of kilowatts. The figures on this scale are placed directly above or below the figures for current and are the same multiplied by the constant as represented by the terminal voltage. For example, on an ammeter for a 600-volt rotary the kilowatt readings corresponding to 1,000 amp. would be 600 kw., to 1,200 amp. 720 kw., etc. Using an ammeter in this way is often most convenient for the station attendant, whether for operating or in compiling statistics or keeping the station log. It saves a little mental exertion and costs nothing to carry out.

The best way to do the printing is to use a rubber stamp consisting of a holder and a set of rubber letters, such as can be purchased for 25 cents at any stationary store. Before attempting to stamp the scale on the meter, lines should be lightly drawn parallel to the values on the current scale so that all figures will be properly centered and aligned. It will usually be found to make a better appearance if the scale of kilowatts is done in red with the current scale in black. This makes a nice contrast scale and gives a pleasing appearance.

In carrying out the idea it should be remembered that it is only applicable to meters on constant-potential circuits and with direct current. It is not applicable with alternating current because of the power-factor variation that occurs. In alternating-current circuits the scale may be made to represent apparent power or kilovolt-amperes, however, upon which the heating of the apparatus depends.

Clinkering of Bituminous Coal--I

By F. C. Hubley*

To promote efficiency of operation and reduce the cost of steam production, it has become more or less of a practice in recent years for large steam users to purchase coal subject to specifications, which, though rigid in a sense, are made broad enough to permit of the use of the output of mines from a number of districts. In general a standard fuel is specified in terms of proximate analysis, sulphur content and heating value, a price per ton for this standard is agreed upon and a bonus or penalty provided for grades of fuel above or below this standard. As a rule no particular mention is made of clinker-forming properties, or at best, a clause is inserted providing for the rejection of the fuel provided steam pressure cannot be maintained under ordinary conditions of operation.

With high rates of combustion which have become so general, clinkering of the ash of the coal is one of the most serious problems confronting boiler-room management and the selection of the coal used. This article, together with the three more that form this series by Mr. Hubley, are among the most thorough and enlightening that have come to our attention. The author states the objections to the Seger cone method of testing for the fusing and fusing range of ash samples, describes apparatus for testing samples and analyzes many curves plotted after tests with the apparatus and studied in connection with reports on the characteristics of the fuels the ash of which was tested, as found in the boiler room.

The subject of clinkers has been widely discussed in Power, and a list of some of the most notable articles that have appeared follows: "Fusing Temperatures of Ash," Bailey and Calkins, Nov. 8, 1910, pp. 1978-9; "Fusing Temperatures of Ash," Wing (discussion of the previously mentioned article), Dec. 27, 1910, pp. 2285-6; "Fusing Temperatures of Ash," Bailey (reply to Mr. Wing), Feb. 7, 1911, pp. 242-3; "Fusing Temperature of Coal Ash," Bailey, Nov. 28, 1911, pp. 802-6; "Ash and Clinker," Editorial, July 9, 1912, p. 60; "The Cause and Remedy for Clinker," Webster, Feb. 17, 1914, pp. 250-2; "Some Mechanical Kinks to Prevent Clinkering," Feb. 24, 1914, pp. 259-60; "Salt Softens Clinker on Sidewalls," June 30, 1914, p. 933; "Clinkering Properties of Coal," Hubley, Dec. 1, 1914, p. 796; "The Clinkering of Coal," Marks, Dec. 29, 1914, pp. 932-4; "Cause and Prevention of Clinker," Bureau of Mines, Aug. 31, 1915, pp. 302-4.—Editor.

Under this system of fuel purchase it frequently happens that a coal will earn a larger bonus than its steam-producing ability warrants, all costs being considered, the result being that the specification, which more or less effectively covers all other properties, fails in its original purpose of grading the fuel in value for steaming purposes.

The failure of most specifications to effectively regulate or provide limits for this property—a matter of as much, if not more, importance than the heating value of the fuel—is in all probability due to the lack of a standard laboratory test for the determination of the clinkering tendency. It naturally follows that if such a test were devised, from the results of which it would be possible to indicate or predict the clinkering tendency of the fuel, an additional clause could be inserted in the usual form of specifications, which should protect the buyer from this trouble.

From these considerations it would appear that, in addition to moisture, volatile matter, fixed carbon, ash, sulphur and heat-unit value of a fuel, it is necessary to determine the length and position of the fusing range of the ash and the nature of the fusion, to have an accurate knowledge of a fuel; which data, in connection with some idea of the maximum required rate of combustion and its corresponding furnace temperature, can then be used with expert design of a proposed boiler plant or the intelligent purchase of fuel for an old installation.

The ordinary conception of the term "fusing point" as applied to a compound, namely, a fixed temperature at which transition from a solid to a liquid state occurs, is misleading and inapplicable to most substances. The temperatures on the scale between which a compound changes from a rigid solid to a thin liquid are in general widely separated, and in all instances the interval has a measurable range. Therefore, in the consideration of a complex mixture such as coal ash, although the term "fusing point" cannot be fixed or defined, the term "fusing range" is capable of precise definition and experimental determination.

It should therefore be noted in the following discussion that where reference is made to "fusing point," it is intended to denote an arbitrary temperature in the fusing range, the recognition of which will be a requirement in the experimental determination of the fusing range of a coal ash.

While modifications of the Seger cone method have been used almost exclusively for ash-fusion tests, it would appear that this test is subject to certain limitations and sources of error which should be eliminated in a standard laboratory test. The principal objections to the cone test are: (1) The personal equation of the experimenter entering into the judgment of the end point of the fusion. It has been observed that two laboratories working on the same ash sample have at times produced widely different results, which must be due to causes other than pyrometric error. (2) The lack of any definite record other than inspection, of the different stages of viscosity throughout the softening range. It would appear from comparisons of results of fusing tests with results obtained under the boiler, that specification of the fusing point alone will not suffice for an effective specification, and that some note of the rate of change in viscosity throughout the softening range must be made. This is especially true when the specified final fusing point is made low, to broaden the buying field for the coal. (3) The necessary

*Engineer, American Bridge Co.

use of a binder in forming the cones, the amount used depending on the amount of natural binder already in the ash, which experience has shown to vary greatly The effect of dextrin, or other binder composed largely of volatile hydrocarbons, on the ash fusion is a variable one the nature and extent of which will be taken up in later paragraphs.

In attempting to devise a more rapid and accurate method of determining the fusing range of a coal ash,

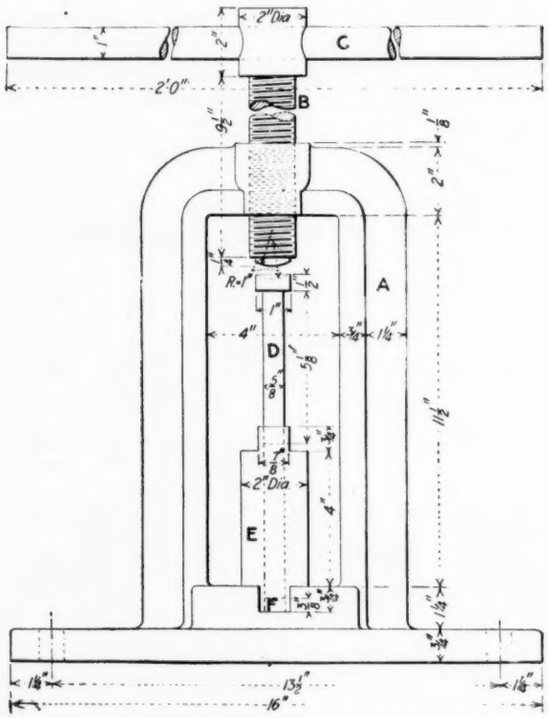


FIG. 1. PRESS FOR FORMING ASH PELLETS

it would appear that if a sample of ash be formed into a hard pellet under considerable pressure and this pellet placed in a furnace under a slight compression, the variation in thickness of the pellet under a steadily increasing temperature will be a measure of the rate of softening at any temperature, the first movement indicating the beginning of the fusing range and the final stage being complete fluidity of the sample. To perform such a test, an instrument called the fusiometer has been devised, which in indicating under an increasing temperature the start and progress of the softening of the test pellet enables the investigator to make a thorough exploration of the fusing range of the substance. A test of coal ash under these conditions may be described as follows:

As in the cone method, a representative sample of the coal is crushed to pass a 60-mesh screen and burned down at a dull-red heat (approximately 1,250 deg. F.) to fine ash. The mixing of the resultant ash should be thorough if concordant results are to be obtained in subsequent fusion tests, since the slightest segregation of the more potent fluxes, which exist in comparatively small percentages in the general sample, will largely influence the position and extent of the fusing range of the ash on the temperature scale. If exact results are required, it would probably be advisable to further crush the general ash sample to pass 100-mesh screen before mixing and selecting samples for fusion.

The test pellet, which is cylindrical in form, $\frac{5}{8}$ in. in diameter and from $\frac{7}{16}$ in. to $\frac{11}{16}$ in. in height, is formed in a hand press similar in construction to the one shown in Fig. 1. This press is designed to exert a unit pressure of approximately 25,000 lb. per sq.in. on the pellet, under which conditions the dry pulverized ash may be compressed into a hard cylinder without the use of a binder. Referring to Fig. 1, the housing *A* is made of cast steel, the mold *E*, plunger *D* and plug *F* of tool steel, hardened and ground to a sliding fit with one another. With the plug *F* held in position, as shown, the mold is filled with a representative ash sample, the plunger inserted and forced downward until maximum compression is obtained. The screw is then backed off and the mold lifted from the groove in the housing and turned through a 90-deg. angle. Pressure is again exerted and the plug *F* and ash cylinder forced out in turn.

After experimenting in the construction of various designs of fusiometers, the form shown in Fig. 2 was adopted as being best suited, mechanically speaking, to carry out the proposed fusion tests. The test pellet *W* is held centrally in the furnace *A* by the carbon rods *C* and *D*. These rods are ordinary arc-lamp carbons ½ in. in diameter. Rod *D*, which supports the test pellet, is immovable in the position shown, being held by the clamp *E* to the bottom of the furnace body. Rod *C* and weights *L* and *N* are free to move in a vertical direction, and in this particular instrument are designed to exert a unit pressure of 1.5 lb. per sq.in. on the pellet. Rod *C* is held on the center line of the instrument by four guide wheels as shown. A silk cord connects the rod *C* and weights *M* with the pivoted pulley *S* and counterweight *P*. The pointer *V* is fixed to the pulley *S* and indicates on the scale on plate *U*. The pulley *S* is 1 in. diameter and the pointer 6 in. long, so that any vertical movement of the carbon *C* due to softening of the test pellet is magnified twelve times on the scale, the total collapse of a pellet $\frac{5}{8}$ in. in height being indicated by a movement of the pointer over 7½ units on the scale. The several parts of the instrument are supported on two 1½-in. diameter rods, fixed in a heavy cast-iron base, this construction being considered necessary to obtain proper rigidity of the fixed points.

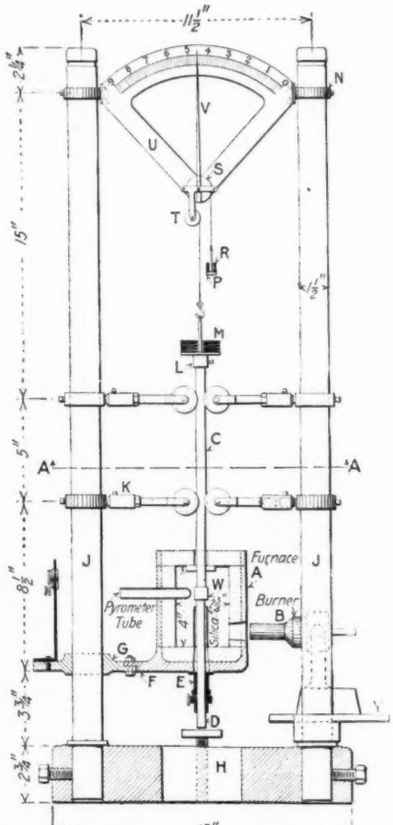


FIG. 2. FUSIOMETER FOR TESTING FUSING CHARACTERISTICS OF ASH PELLETS

In experiments carried out by the writer, a gas-heated furnace was used, the position of the burner being at *B*. The carbon *D* is protected for a part of its length from the direct action of the flame by a porcelain tube, as shown. When this method of heating is used, the carbons slowly reduce in diameter and from time to time must be replaced by fresh rods. From six to eight tests may be completed with one pair of rods without excessive reduction of the rod diameter. Temperature measurements are made with a platinum-rhodium thermocouple. The porcelain protecting tube for this couple is shown in position, so that the couple bead is in close proximity to the ash pellet.

With the ash pellet and carbons in the position shown and the pointer adjusted midway between zero and 1 on the scale, the furnace is gradually heated at the rate of from 50 deg. F. to 100 deg. F. per minute, simultaneous temperature and scale readings being made at half-minute intervals. As the heat is increased, negative movement of the pointer will indicate carbon expansion up to a temperature where the first softening of the ash pellet is indicated by a positive movement of the pointer. The experiment is continued till the final collapse of the pellet is indicated on the scale.

These results, if plotted, the temperatures as abscissa and the scale movement as ordinates, produce a curve an ordinate of which at any point is a measure of the softening of the ash pellet at that temperature. This curve is parallel to the temperature axis at the first softening of the ash, becoming parallel to the scale axis at or near the melting point, thus giving a diagram of the complete fusing range of the ash under test.

As previously stated in this discussion, the term "fusing point" is misleading and indeterminate, while "fusing range" of a substance can be determined with exactitude.

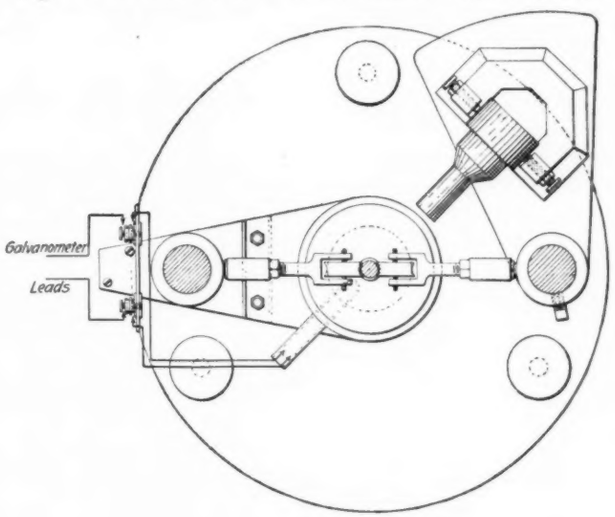


FIG. 3. PLAN VIEW OF FUSIOMETER

However, for purposes of relative comparison, an arbitrary point in the fusing range may be selected and called the "fusing point" of the ash. For this point, in the case of the fusiometer results, the writer suggests the temperature at which the pellet has collapsed due to softening to one-half its original height. It must be noted, however, that while this arbitrary temperature is of some value in grading coals as to their probable clinkering tendency, the loss by clinker formation in the boiler fires can be governed only by the length and position of the softening range and the nature of the fusion. While two ashes may have the same final melting point and length of softening range and the coal be consumed at the same fuel-bed temperature, nevertheless the variation in viscosity throughout the softening range will produce different clinker formation for the two fuels.

For a new instrument with a platinum-rhodium thermocouple of unknown millivoltage-temperature scale, a ready means of calibration presents itself. Test cylinders of pure metals or standard substances having sharply defined melting points are placed in the furnace *A*, Fig. 2, in the usual position for an ash cylinder, and the fusing curve developed as described in previous paragraphs. Since the fusiometer was designed primarily for the investigation of coal-ash fusion, its working-temperature range will be between 1,400 deg. and 3,000 deg. F. It has therefore been considered sufficient, in the calibration, to develop two points only, and for this purpose nickel and copper were selected.

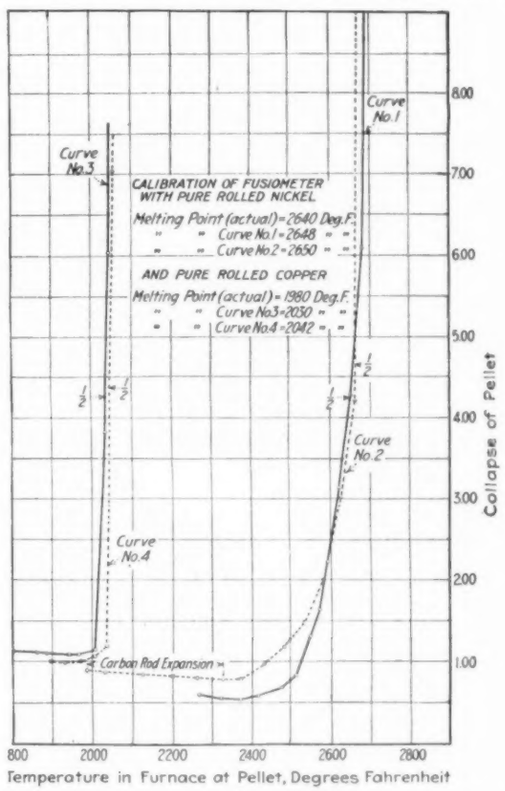


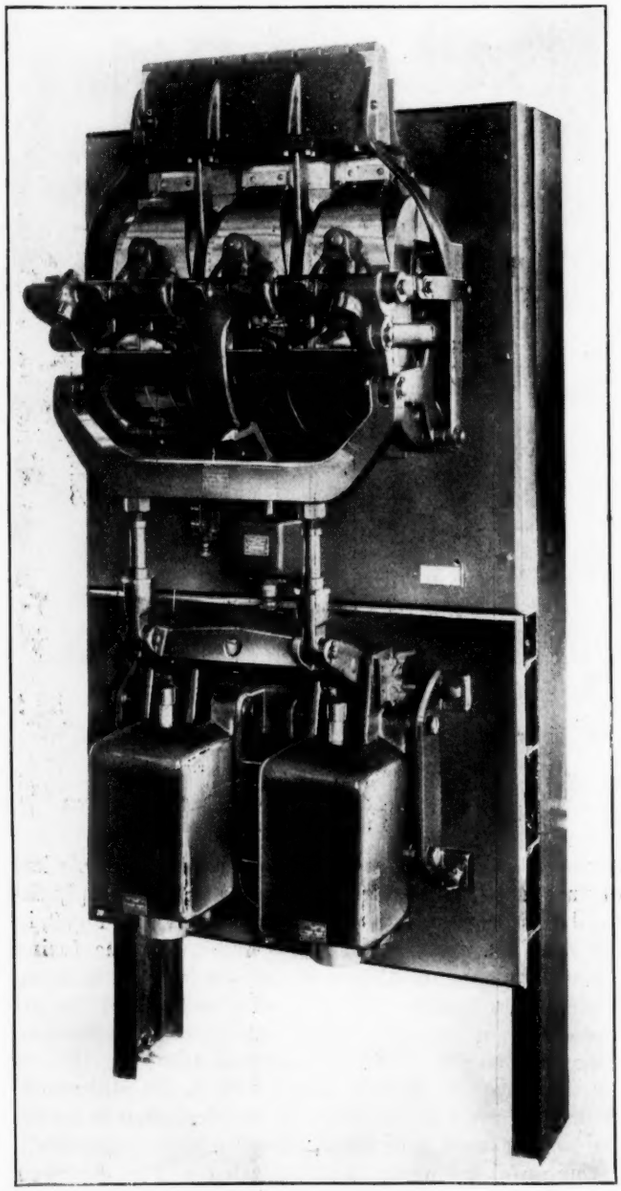
FIG. 4. CURVES PLOTTED AFTER CALIBRATING FUSIOMETER

Curves of this nature are illustrated in Fig. 4. Such a calibration will of course include the error of the platinum-rhodium couple and galvanometer and the lag of this couple behind the actual temperature of the test pellet, as well as the effect of the friction of the moving parts of the instrument.

Artificial Ventilation is produced in one of two ways, ordinarily known as the "vacuum" method and the "plenum" method. The former consists of withdrawing the air by some means, causing a partial vacuum in the room and allowing the air to find its way in by a special inlet or any chance crevice. The plenum method is that in which the air is forced in by artificial means and allowed to find its way out. The advantage of the second method is that it is known whence the air comes which is forced in. In most cases, however, the vacuum method is much more easily applied.

A Large D.C. Circuit-Breaker

The 20,000-amp. direct-current circuit-breaker shown in the illustration is the most recent solenoid-operated type developed by the General Electric Co. for controlling direct-current circuits of unusually high capacity and has a normal continuous rating of 20,000 amp. This circuit-breaker is one of four of the same capacity built for the Aluminum Company of America for installation at Massena, N. Y. The closing and opening movements under normal conditions are controlled by a single-pole double-throw control switch mounted remote from the breaker on the switchboard or in any other convenient location. On overload or short-circuit the breaker opens automatically by means of a direct-acting trip. The breaker is mounted on a 2.5-in. slate panel, with the solenoid mechanism supported on a steel base at the bottom of the panel. The use of solenoid-operated and other types of distant-controlled circuit-breakers simplifies station wiring, reduces length of main cables and economizes space.



CIRCUIT-BREAKER OF 20,000-AMPERE CAPACITY

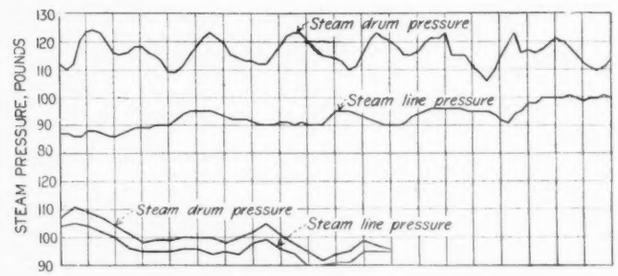
Mud Plugs Dry Pipe

By F. C. Torrance

Pressure tests were recently made to locate and determine the cause of an excessive pressure drop that occurred between the front drum of a Stirling boiler and the steam main.

There were four boilers cut in on the line. The one in question was equipped with blowers for automatically regulating the steam pressure. These blowers were installed so that when the line pressure reached a certain amount they would shut off, and would start again when the pressure decreased. For some time there had been trouble with the blowers. At times they would work all right, and then again they would let the pressure build up until the safety valve popped, or they would not release the pressure so that the blowers could start when the pressure, as read on the gage located on the boiler, got low. It was also noticed that the pressure in the boiler equipped with blowers was always 25 or 30 lb. higher than in any of the others. These gages had all been tested and were known to be correct.

To determine the cause for the drop in pressure and also the failure of the regulator to work, standard gages



SHOWING VARIATIONS IN PRESSURES

were attached to the front drum of the boiler and to the nozzle just above the dry pipe. Readings of these gages were taken simultaneously. No time intervals were used, but whenever the drum pressure varied the gages were read. The results of these readings are shown by the two upper curves. These curves show some interesting points. First there is a difference in pressure between the boiler drum and the line. Then, too, the line pressure does not show any extensive or rapid pressure changes, while the boiler pressure fluctuates over a wide range.

At this time a new boiler was started, with blowers operating from the same regulating valve. The same kind of a test was run on this, with different results. It was found that the pressures were only from 3 to 5 lb. apart instead of 25 or 30 lb. as on the first boiler. The results of this test are shown by the two lower curves.

From these two tests it was apparent that the trouble was inside the boiler; the line pressure was taken between the valve and the boiler drum. As soon as possible the boiler was taken out of service and an examination made. It was found that the holes in the dry pipe were almost entirely closed. This condition was caused by the water supply, which had been obtained from a point near which dredging had been going on. The mud and other impurities were pumped into the boiler and had caused priming. This had thrown the mud up on the dry pipe and so stopped the outlets. The holes were cleaned, and the pressures on all the boilers were alike.

Editorials

The Small Geared Steam Turbine

When Professor De Laval first introduced his simple impulse turbine, he found it necessary to run the turbine at very high speeds to secure good economy. But these speeds were too high for the electrical machines of that day; hence in order to adapt the turbine to electrical generation, it was found necessary to introduce a high-speed pinion on the turbine shaft, driving a low-speed gear connected to the generator. This method is still used by builders of De Laval turbines on small units.

The other types of turbines that were introduced at nearly the same time or later, such as the Parsons, the Rateau and the Curtis, were at first designed to run at much more moderate speeds, so that they could be direct-connected to electrical machinery or to pumps without the use of intermediate gearing. In recent years a large number of turbines of the simple impulse type have been built in this country, in which the steam is redirected so as to impinge on the blades a number of times and thus permit lower wheel speeds and direct connection to electrical generators without intermediate gearing. The Terry, Sturtevant, Westinghouse Impulse, Electra and others were of this type.

Quite recently one of the largest turbine builders in this country has developed a new line of simple impulse turbines to run at speeds of six to seven thousand revolutions per minute and to be connected through gears to the generators or pumps they are to drive. These units have met with a considerable measure of success and are increasing rapidly in popularity. One naturally will ask why there has been a return to the geared unit after the development of the slow-speed repeated-flow simple impulse turbines.

The most important consideration and one that was recognized by Professor De Laval is that of economy. It is said that high-speed geared units will show a gain in steam economy of perhaps fifteen per cent. over the repeated-flow type, slower-speed direct-connected units. This is principally due to the higher blade speeds employed and to the smaller friction losses. Naturally the earlier gears were not so skillfully cut as is now possible, and some difficulty was experienced with wearing of the teeth. It has since been found that with accurately cut teeth the wear is practically negligible provided the surfaces of contact are kept flooded with suitable oil. But there is an appreciable loss of power from churning up the oil if the gear case is kept too full. Hence, oil pumps, coolers and forced systems of lubrication have been introduced to provide this necessary oil supply in the desired quantity and at the proper place.

Gears were also known to cut out badly if not adjusted always to the proper depth of contact. Messrs. Westinghouse and MacAlpine introduced their floating frame to overcome this difficulty. However, at about the same time, Sir Charles Parsons was using on his large turbines gears without special provision for adjustment other than accurately made bearings which were kept well lubricated. This apparently has been all that is necessary, for the newer American types are not provided with any special devices to keep them in proper alignment, yet they have proved very satisfactory.

The earlier gears were usually of bronze. High-carbon steel seemed better suited to this purpose and is now used to a great extent. This change of metals has also proved a step in the right direction.

The small-geared turbine provides a cheap, light-weight and economical unit. It can be readily adapted for driving direct- or alternating-current generators, slow-speed fans, centrifugal pumps and other similar units. The geared turbine will not cause any revolution in power-plant practice, but it will gradually find its place as engineers come to realize its advantages and its adaptability to special conditions and particular uses.

The Young Engineer's Outlook

What has the young engineer to look forward to? This is a question frequently asked, and asked with varying degrees or shades of suggestion and inference. One will put it in a way that conveys the conviction that there can be but one answer—nothing. To the fellow who feels that way about it, that answer is probably correct, for he will not be likely to get more than he strives for, except by accident, and enthusiastic effort is impossible where a feeling of discouragement as to results is entertained. This is so basic, of course, as to permit of no argument. A child not over two and a half years old, when reproached with "bad boy," voiced this truth in his natural resentment: "You say I bad boy I be bad, you say I good boy I be good." Yet how often we tell ourselves or others that our particular job or line of work is the worst of all and the only one in which there is absolutely no chance to get ahead. This is applied to every branch of human endeavor at the hands or, worse, the tongue of some engaged in it. There is an old Scotch proverbial saying, "It's an ill bird that fouls his own nest," that applies with equal force to the croaker against his own means of earning a livelihood.

The opportunities the occupation of steam engineering has to offer the ambitious young man are numerous and varied, depending as they do on the degree of energy, health, education, environment, temperament and freedom of action the individual may or may not enjoy. Energy is placed first, for engineering is not a lazy man's job and distinction is not attained by the slothful. Energy is of course largely dependent on health and strength, mental and physical. A good education gives an immense advantage. The term education is here used in its true essential meaning, not merely based on a prescribed and recognized course of study which in itself is splendid, but is to be considered the means and not the end of education. Environment influences education and ultimate attainment in various ways and constitutes

a large part of the former and a means of measuring or gaging the latter. Being fortunate enough to be thrown in contact with intelligent, thinking people as contrasted with the opposite sometimes accounts for the whole difference 'twixt man and man. Temperament determines the selection of companions or environment when selection is possible, and a studious temperament is likely to turn to books for companionship. It is in this particular that authors or near authors assume a grave responsibility in giving, in some cases, a mere mess of pottage in return for the price paid and, what is more valuable, the time and effort expended—as honorable as any other "bunco" man or a "short weight" dealer.

Freedom of action is a great privilege, enjoyed by some but denied many. Conditions such as the responsibility for the welfare of others dependent on the immediate earning capacity of a young man, that limit the choice of occupation to that at hand while better opportunities lie beyond, are usually, though not always, detrimental. They may simply extend the preparatory training for big things. Given a fair amount of energy, good health, an education that is practical or one that enables him to "use his head," the young engineer will choose or create an environment, especially outside of working hours, in accordance with his temperament, that will help him up or down, and the degree of freedom of action will be the deciding factor as to how far he will go in either direction and how soon he will arrive at success or failure.

No young man should ask or require more than the equipment outlined to make a creditable showing in his life work—to make the best of himself, a thoroughly useful man, which is as high as the highest have attained.

Rate of Depreciation

The cost per unit output of steam and electrical machinery of given speed decreases as the capacity increases. In considering the depreciation of this equipment the inverse is found to be true; namely, the depreciation increases with the capacity. Fair values can usually be realized for units of less than five hundred horsepower, in good order, when sold second-hand. Especially is this true of electrical machinery of less than one hundred horsepower, as witnessed by the large amount of this class of machinery handled each year in the second-hand markets.

When machines of large capacity are considered, the chances of disposing of them for other than junk are small. Not because large machines wear out faster than small ones—quite the reverse is true, especially in central stations, where the equipment is maintained at the highest degree of efficiency even to the extent that the machinery is usually in better condition than when installed.

The cause of this high rate of depreciation on large machines is that they outlive their efficient usefulness. In small plants the loss due to a slight decrease in efficiency may not appear to be of any consequence, particularly in a large industry where the power equipment is only a small part of the whole. When the same decrease in efficiency is considered in plants of five hundred to one thousand times the capacity of a small one, it will amount to a large figure and make a very attractive proposition for the owner to dispose of the old machines and install new ones.

An interesting example of how fast large engines and generators depreciate is found in the case of a large central station built some fifteen years ago; thirteen years later, to increase the capacity of the plant, it was decided to dispose of four of the original machines, which were 5,000-kw. engine-driven units, and replace them by turbine-driven units. An attempt was made to dispose of the 5,000-kw. machines by advertising in the various technical papers, but no market was found for them. These machines were in as good condition as when new and cost approximately one-quarter of a million dollars each to install, but were sold for scrap at about ten thousand dollars.

Overhauling Time in the Refrigeration Plant

Besides heralding the coming of winter, these frosty mornings and chill days are a reminder that before long the refrigeration load will be decreased greatly, giving an opportunity to overhaul the system so that when winter breaks up there will be less to do in the short time seemingly required for spring to make necessary the service of the equipment. To follow this plan is to be prepared.

Among the things every engineer will busy himself with is cleaning the condenser absorber. Perhaps also, the generator should be cleaned and the steam coils tested for leaks. The sulphur stick will likely be used widely for discovering ammonia leaks here and there, so that new pipe or nipples or gaskets may be put in place in readiness for starting the system when the busy season again approaches.

The compressor, of course, will come in for its share of attention, and here is where the operator's skill will have to be exercised to put everything in good running condition, for ammonia compressors usually go into service for long periods when started, and there must be no avoidable weaknesses to develop when continuous service is vital. Maybe some parts subject to motion and strain are becoming dangerously crystallized and will give out when worked hardest on the peak loads. How is the operator to know? Can he know? Well, experience with the particular machine and with the material of which the parts are made is his only true guide.

Perhaps the publicity given the ammonia explosions which have occurred in refrigeration plants with usually fatal results will move many to do away with arc lights or other open flames. Quite likely, too, the putting up of a fireproof door, automatically shutting off communication between the boiler and the engine room, will be a desirable job for the slack season.

Where the blowing of a fuse may shut down electrically operated circulating-water pumps long enough to dangerously increase the head pressure, some holder for these fuses located in or near the switch panel would be desirable.

There are many jobs about a refrigeration plant that need being done, and as the off season approaches these should be made note of and checked off as soon as completed.

Correspondence

Capacities of Chimneys

In the issue of Aug. 22, there is a valuable article on the subject "Capacities of Chimneys," in which authorities are quoted for values for constant K, among whom is Brinckerhoff, "$K = 18.1$." I was wondering if this referred to me. I wrote a paper on the subject many years ago and worked out some results intended as examples of method, taking, as I pointed out, such abnormal constant values that no one, I hoped, would be misled so far as to accept the same practically. They were intended to assist the engineer's own intelligence in giving the constants such value as his particular conditions required.

If we consider the chimney as a machine in the same sense that we would a windmill, our effort would be to build it as economically as necessary to produce as high an efficiency as possible. The chimney should be regarded as a type of heat engine producing work; indeed it would not be difficult to make it do other mechanical work than pumping air.

Coming back now to the efficiency of the chimney, it is heat and heat alone that makes it produce draft. The stack empty of heated air gives no draft power by reason of its height and area. We know overhead wind currents or the sun's heat on the sides will produce suction enough sometimes to lift a man's hat, but these incidents do not affect the general statement. It is the waste boiler gases that we must depend upon to burn the coal, so the hotter these are and the higher the column the stronger the draft, and to conserve the heat we should have the lowest minimum area possible to carry away the waste gases.

The use of the general formulas in present practice does tend to waste this heat by reason of providing excessive area. This results in costly investment for chimneys and often requires mechanical-draft blowers, consuming 5 per cent. of all the steam made and sometimes more, where a properly designed chimney would do the work unaided.

The engineer, I take it, is not concerned in the contractor's extra profit from an excessive chimney or in the profits by those manufacturing artificial-draft appliances, so he ought to be interested in getting all his necessary draft, or the utmost he can, from the chimney he intends to build.

Mr Orrok makes the statement, "There is no doubt that the cooling of the gases due to radiation and leakage lessens the draft." Is it not plain that the surface area must be the source of this loss? The closer we can make the area, therefore, to suit the actual need, the more efficient will be the stack.

Take a concrete example where you answered an engineer in the Sept. 12, 1916, issue, based upon Kent's formula, advising the diameter to be 11 ft. 8 in. if 200 ft. high, to be right for 4,800 boiler horsepower. You rightly made it clear that the formula was based on using 5 lb. of coal per horsepower and would provide for the contingency of overload. Let us hope he gave this due weight and has not grasped ignorantly at the resultant figures.

You answered under the circumstances safely, so probably it is accepted to be safe by the engineer—both resting on Mr. Kent's formula. Should the chimney prove inadequate, with the diameter as recommended, to get proper duty from some of the farthest boilers, the owner can buy more boilers to gain thinner fires on the increased grate area or he can supplement any lack by purchasing artificial-draft apparatus. Of course, the chimney is all right because the proportions were in accordance with the best engineering talent in the country.

But suppose they seldom ran all boilers or, if they did, their fuel easily produced a boiler horsepower with 3.5 lb. coal per hr., using only 20 lb. of air. If so, with gases at 500 deg., the velocity would be theoretically about 6,000 ft. per min., calling for 5 : ½ ft. chimney diameter. Looks absurd, although many instances can be cited of chimneys performing very close to their theoretical limitations. Allow it is unsafe, does it not strike one as if 11 ft. 8 in. diameter (107 sq.ft.) gave a pretty big margin? If you could safely do with less area, would it not save a large cost on the chimney and at the same time reduce the exposed surface that cools the gases and lessens the pull?

In heating and ventilating work for factories where slight noise of travel can be disregarded and where heavier air has to be conducted through small pipes and all sorts of bends and discharges, engineers usually employ 1,800 ft. per min. of travel without 4 in. of extra diameter. Why is not the same velocity reasonable in allowing for a straight travel, when we know the actual pull is in excess?

If one will remember that 1 lb. of coal per hour, using 20 lb. of air, will produce 8 cu.ft. of gas per minute, it will help to work out the area for this or any velocity that one's judgment deems safer to adopt. Employing this new constant, 1,800 ft. for velocity, we have

$$\frac{4{,}800 \times 3.5 \times 8}{1{,}800} = 75 \textit{ sq.ft.} = 9 \textit{ ft. } 9 \textit{ in. diameter}$$

Now if the owner of the 32 horizontal return-tubular boilers does not wish to provide for a future overload and feels sure of his regular coal quality and supply and therefore adopts the 9 ft. 9 in. diameter, he will save in chimney structure several thousand bricks as well as the cost for heavier foundation. Also he will gain a much stronger and more efficient draft by reason of having less chimney surface. Even if the unneeded chimney surface did not weaken the draft by air leakage, the radiation from additional surface which must be heated and then maintained in temperature causes a loss of the limited supply of the heat previously required to produce the needed draft.

The inside surface area of two chimneys each 200 ft. high and having 75 and 107 sq.ft. respectively, is as 6,135 and 7,390, or a difference of 1,255 sq.ft. The resultant loss therefrom must seem apparent to anyone and is very real. If the gases enter at 500 deg. and could be maintained, the draft would be 1.22 in.; but if reduced to

350 deg., becomes 0.78 in., making more than a third loss in the available draft.

I have always advocated that chimneys should be as high as possible and with the smallest practical area. I have never given a constant until now for area and even its use requires judgment, as in assuming the pounds of coal used per hour per horsepower, the amount of air and the provision for overload.

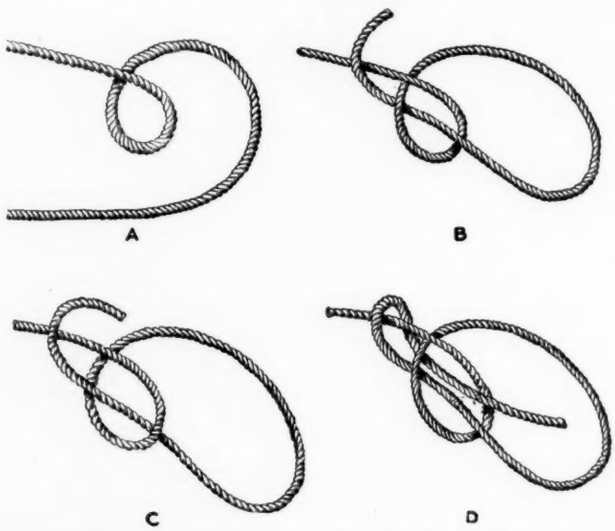
I hope the foregoing, purposely divested of technicalities, will be regarded as sufficiently simple for engineers to employ so they will break away from the easy reference to "Tables of Sizes of Chimneys for Given Boiler Horsepowers," and thereby save money and get better draft.

H. G. BRINCKERHOFF.

Greenfield, Mass.

Tying a Bowline Knot

On page 342 of the issue of Sept. 5 Mr. West describes two methods of forming a bowline knot, but in the interests of safety I would like to call attention to the fact that passing the end of the line through the loop



ONLY ONE WAY TO TIE A TRUE BOWLINE KNOT

as shown at *C* in the illustration does not and cannot produce a bowline knot. The proper way to begin such a knot is shown at *B* and the finished knot at *D*. In either a bowline knot, bowline on a bight or bowline with a bight, the two parts of the rope that pass through the small loop are always put through so as to lie parallel and to cross the top of the small loop on the opposite side from the main rope, as shown at *D*, using the original illustration.

Huntington, W. Va. E. J. CLARK.

Report Accidents as Warnings

In view of the fact that the "Safety First" movement is so vigorously advocated, with warnings framed and conspicuously displayed in so many power plants, it seems incredible that some of the accidents reported from time to time could have happened. The warnings conveyed by these signs and cards are heeded by many, nevertheless in many cases the exercise of some simple precautions would have averted both the injury to employees and the trouble with apparatus.

The letter by A. W. Conklin in the issue of Sept. 1 page 391, brings to mind an experience when a simila accident was narrowly averted. A high-pressure hot water valve was to be repaired, and assuming the line to be free from pressure, two workmen started to remove the valve bonnet. After slacking the nuts slightly, one of the men inserted a wedge under the bonnet flange to satisfy himself as to the actual condition of the line, whereupon it was found to be under full boiler pressure. Fortunately the nuts were still on and they were able to pull them down and stop the flow of scalding water without being injured.

A dangerous practice, which should be prohibited by those in charge of plants, is that of removing the nuts from a manhole or handhole plate and suddenly driving the plate back from its position, for in the event of a boiler containing considerable water the lack of control over it in such a case would make it almost impossible for the workman to escape from its path. The danger involved in handling steam and hot water under high pressure is rarely appreciated by persons who have never observed the destruction wrought by these elements when out of control. This fact is no doubt largely responsible for many performances that may be classed as foolhardy. Many employees in power plants hear nothing of accidents that are reported in various engineering periodicals or do not heed them, and it is therefore suggested that engineers and others in charge bring these accounts to the attention of their subordinates whenever practicable, explaining that the information is published to further the "Safety First" movement and help to avoid similar accidents.

I. S. CHAMBERLAIN.

Jersey City, N. J.

A Dissatisfied Diesel User

I have reviewed with much interest the discussions appearing in *Power* regarding Diesel engines. Most of these articles, however, deal with "Heat Maladies of Marine Diesels" and discussions of the relative merits of two- and four-stroke-cycle types as applied to ship propulsion. I would inquire further why more manufacturers of stationary Diesels do not attempt engines of the horizontal type rather than the vertical.

Judging from appearances, many American manufacturers of vertical Diesel engines have displayed a remarkably small amount of originality in some of their designs, their products resembling a cross between a vertical marine engine and the American motor-car engine. Cannot these designers successfully design a horizontal multicylinder engine operating on the Diesel principle? Or if they must build the vertical type, why must the cranks in most cases be entirely inclosed and made almost inaccessible for repairs and adjustments? Also why is it necessary to house over the main bearings until they cannot be examined while the engine is in operation?

I have no desire to appear sarcastic in my remarks, yet after six months' operation of two such engines as mentioned in the foregoing paragraph, I feel no hesitation in saying that if all vertical Diesel-type engines are like the ones in our plant, I certainly feel sorry for their misguided operators and owners.

Aside from the matter of fuel economy, which is wonderful, I cannot see that this type of Diesel engine has anything in its favor. Their operation requires about

twice the attention that is necessary with steam units of the same rated capacity, and every part requiring close and accurate adjustment is well nigh inaccessible, especially main bearings and crankpins, which are boxed up with cast-iron doors of unnecessary weight and thickness, that require the combined efforts of two men aided by the traveling crane to remove and replace.

To change or replace the piston rings, involving the removal of the piston, requires the services of four men for a period of 16 hours, aided by a traveling crane. With a horizontal engine and a properly designed crank case, or open crank such as is used by some American engine builders of horizontal engines, this operation could be completed by two men in not to exceed one hour and, moreover, without removing the cylinder head or disturbing the valve gear.

Our units are rated by the builders at 500 b.hp. At this elevation above sea level (5,315 ft.) and allowing an electrical efficiency of generators of 90 per cent., their rating falls to 405 b.hp. or about 304 kw.; yet for these engines to carry this load for ten consecutive hours reduces them to such a state of decrepitude that the sound of their operation is alarming.

I have no wish or intention of condemning the Diesel type of engine, but I am convinced that radical changes may be made in the design of some of the engines now exploited and sold, and such changes need not impair in any way the thermal or mechanical efficiency of this type of prime mover. When American builders of stationary Diesel engines quit importing their designers at handsome salaries, also quit attempting to imitate European practice, and really design to meet the actual requirements of American engine users, then the Diesel type will really come into its own.

There are, happily, several firms in the United States who have departed from the set custom of paying license fees to European builders and who, from all appearances, are building successful horizontal engines; at least their designs indicate an exhaustive analysis of the temperatures and pressures involved, as well as accessibility and ease of adjustment. H. R. Wass.

Casper, Wyo.

Troubles from Well Water

The water bill in a large combined power and refrigerating plant had been a thorn in the side of the management for a long time. The chief engineer suggested sinking wells, and it was decided to do so. The water, after passing through the double-pipe ammonia condensers, was circulated through two steam surface condensers, thence into a large reservoir, from which the supply to the plant was taken.

As the well water was about 60 and the city water about 80 deg., there was a considerable reduction in the condenser pressure of the refrigerating system and an increase in the vacuum, as well as a welcome reduction in the city water consumption, and all hands were congratulated on the increased efficiency of the plant.

Everything went along nicely for several weeks with the well-pump discharge pressure about 25 lb. Gradually this pressure had to be increased to keep up the regular rate of flow through the condensers, and in about a month the pressure had increased to 100 and later to 150 lb., and the pump would barely keep up speed enough to keep the ammonia condenser pressure down. The temperature of the water as it left the steam condensers had also dropped considerably below what it had normally been before the well was started.

The night engineer decided to investigate. He connected a pressure gage at different points along the circulating-water line, to determine where the abnormal pressure was required. This showed that the ammonia condenser was clear, but when the gage was connected at the outlet of the steam condenser, the pressure was found to be practically zero, so it was evident that the trouble was in the steam condensers.

There was a bypass connection around the steam condensers so that the water from the ammonia condenser could be returned directly to the reservoir without going through the steam condensers, in case it was desired to cut these out of service. The engineer gradually opened the valve, but he had only opened it slightly when a terrific racket started in the pumproom; so he shut the valve again, and when he got to the pumproom the oiler told him the pump had suddenly started to run away, but by the time he had got over there it had settled down to normal again. It was evident that opening the bypass at the steam condensers had reduced the pressure and allowed the pump to run away. Posting the oiler, he went back and opened the bypass valve gradually, and the discharge pressure of the pump went down to 25 lb.

When the heads were removed from the steam condenser the next day, the tubes were found scaled up almost solid because of the hard well water that had been used. To prevent recurrence of the trouble another cooling tower was built with separate piping and a small centrifugal circulating pump provided for the surface condensers. The water taken from the city mains is only that lost by evaporation from the tower. E. W. Miller.

Minneapolis, Minn.

Rating and Guarantee of Small Centrifugal Machinery

In the issue of Aug. 8, page 213, Mr. London has a rather lengthy letter upon the "Rating and Guarantee of Small Centrifugal Machinery," which the writer would like to discuss. Everyone will readily admit that

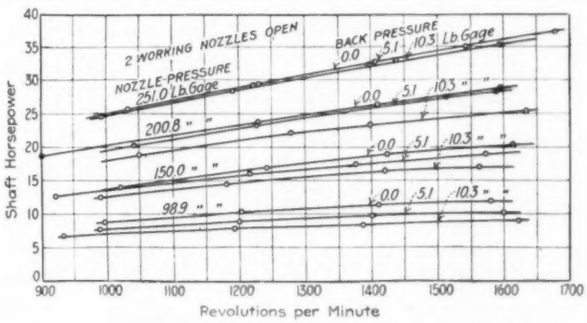


FIG. 1. PERFORMANCE WITH TWO NOZZLES OPEN

a guarantee must be based on "the best guess possible based on interpolation or extrapolation." That is self-evident, but Mr. London does not call attention to the fact that interpolation will give a remarkably correct estimate of performance.

Concerning his estimate of the number of tests required to obtain accurate knowledge of the performance of a

given type of turbine as outlined on page 214, totaling 180,000 tests for a complete analysis of a small turbine, does Mr. London really expect anyone to consider that outline seriously? For example, after making 9,000 tests with varying steam pressure, exhaust pressure and speed, he says "Repeat for ¾, ½, ¼ and no load." The writer

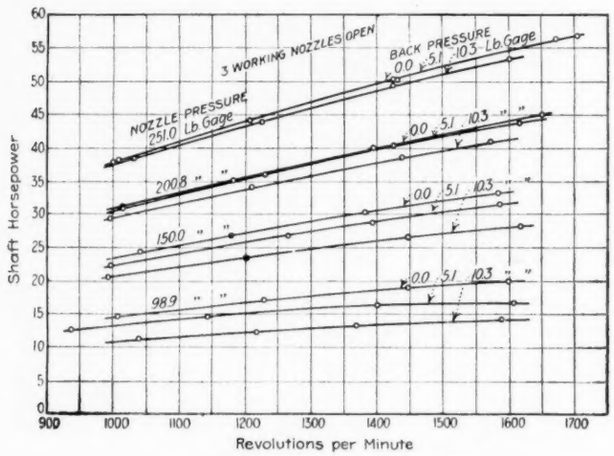


FIG. 2. THREE NOZZLES WORKING

cannot understand what Mr. London intends to do in this case, for surely if the initial pressure, exhaust pressure, speed and number of nozzles open are fixed, the load must be fixed also.

The writer recently tested a small turbine to determine its performance over a wide range of nozzle pressures, back pressures, and speeds between 1,000 and 1,600 r.p.m. The turbine was of the single-stage impulse type, rated 46 hp., at 1,550 r.p.m., with steam at 250 lb. gage and exhaust at 10 lb. gage. There were two nozzles always

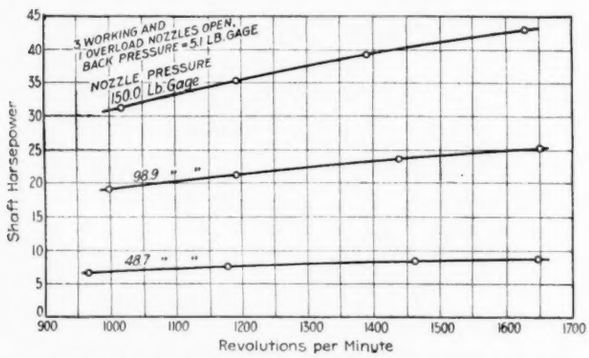


FIG. 3. THREE REGULAR AND ONE OVERLOAD NOZZLES ON

open, one extra working nozzle, and two large nozzles for use in case of overloads or low steam pressure. It was directly connected to an electric dynamometer, and sufficient data were taken to make a complete thermal and mechanical analysis of the performance. The tests were divided into groups according to the nozzle pressure and the number of nozzles open.

A little thought will enable one to realize that, as long as the steam pressure is kept constant, varying the speed or back pressure will have no effect on the total steam used per hour, provided that the absolute back pressure is less than half of the absolute initial pressure in the nozzle ring. This fact gives an easy and rapid way to test a turbine, as will be seen from the following description of a representative group of runs.

For group A the fixed nozzles were the only ones open and the steam pressure in the nozzle ring was held at 100 lb. gage. The exhaust valve in the line leading to the condenser was throttled until the back pressure was exactly atmospheric, and the load on the electric dynamometer was adjusted until a speed of about 1,000 r.p.m.

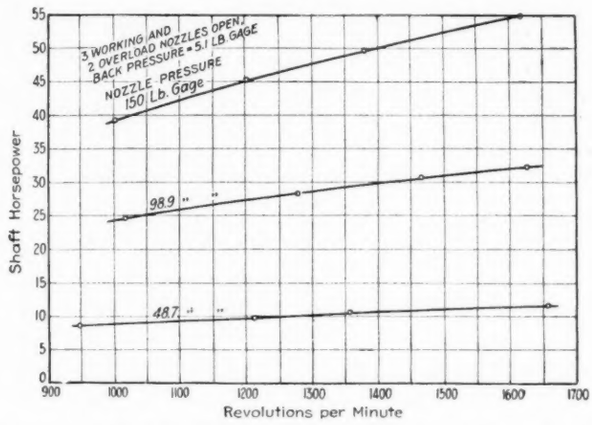


FIG. 4. THREE REGULAR AND TWO OVERLOAD NOZZLES

was obtained. The turbine was then allowed to run for five minutes in order for the speed to settle down, and no more adjustments of the load were made until the run was completed. The speed was read by means of a direct-connected counter geared down 10 to 1. Each run was 10 minutes long, so that the difference between the counter readings at the beginning and the end of the run gave the average revolutions per minute directly. The brake load was read every two minutes, and the average of the

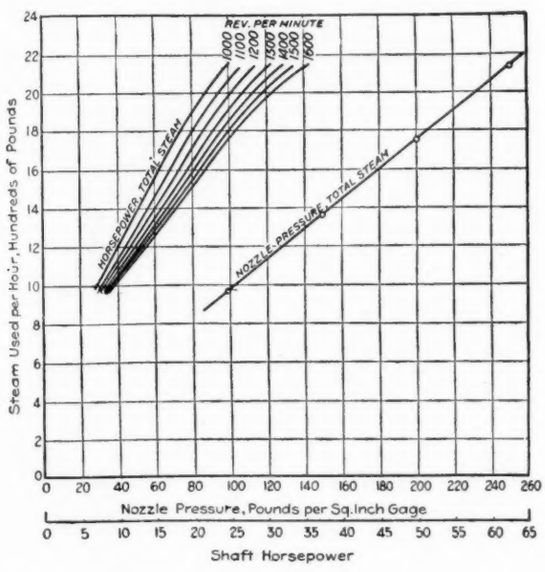


FIG. 5. PROBABLE STEAM REQUIRED PER HOUR

six readings used in computing the results. At the end of a run, without changing either the initial or back pressure, the speed was increased to 1,200 r.p.m. and a run made as before. These were repeated for 1,400 and 1,600 r.p.m., and then the back pressure was raised to 5 lb. gage, the speed brought back to 1,000 r.p.m. and the series repeated. This procedure was also followed with 10 lb. back pressure. In this manner, allowing 10 minutes for a run and 5 minutes between runs the weights

of steam and the quality determinations were extended over a period of three hours, although 12 runs were made in that time. A complete outline of the tests made is given.

	Number of Tests
Group A: 2 nozzles open, 100-lb. nozzle pressure, 0-, 5- and 10-lb. back pressure and 4 speeds between 1,000 and 1,600 r.p.m.	12
Group B: 2 nozzles open, 150-lb. nozzle pressure, other conditions as in Group A	12
Group C: 2 nozzles open, 200-lb. nozzle pressure, other conditions as in Group A	12
Group D: 2 nozzles open, 250-lb. nozzle pressure, other conditions as in Group A	12
Total to date, 12 × 4	48
Groups E, F, G and H, same as Groups A, B, C and D, except that 3 nozzles were open	48
Group I: 4 nozzles open, 50-lb. nozzle pressure, 5-lb. back pressure and 4 speeds between 1,000 and 1,600 r.p.m.	4
Group J: 4 nozzles open, 100-lb. nozzle pressure, other conditions as in Group I	4
Group K: 4 nozzles open, 150-lb. nozzle pressure, other conditions as in Group I	4
Groups L, M and N, same as Groups I, J and K, except that 5 nozzles were open	12
Total number of tests	120

Some of the results of these tests are shown by the curves, Figs. 1 to 6. Figs. 1 to 4 inclusive show the

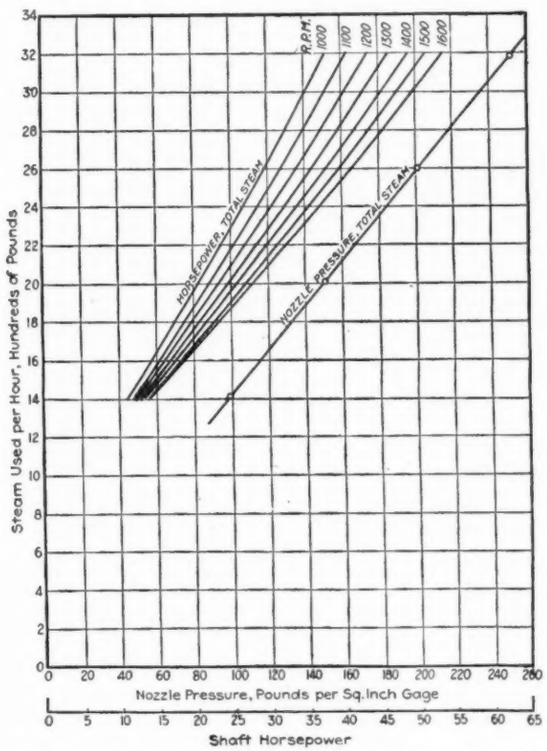


FIG. 6. STEAM PER HOUR FOR GREATER RANGE THAN FIG. 5

actual test data plotted on the coördinates of horsepower and speed. These curves show the effect of varying either the nozzle pressure, back pressure or speed. Fig. 1 shows the performance with 2 nozzles open, Fig. 2 with 3 working nozzles, Fig. 3 with 3 working and 1 overload nozzles, and Fig. 4 with 3 working and 2 overload nozzles open.

Curves similar to those on Figs. 5 and 6 are probably the most useful in making guarantees, as they give the total steam required, in pounds per hour, to produce a given horsepower at a given speed and back pressure. The nozzle pressure required may also be found from the curve of nozzle pressure vs. total steam. These curves are cross-plotted from the 10-lb. back-pressure curves of Figs. 1 and 2, by finding the horsepower and pressure corresponding to various speeds. Since the steam consumed per hour is known for a given pressure, this may be plotted against the horsepower, giving a series of constant-speed lines.

Leaving the subject of turbines and turning for a moment to centrifugal fans and centrifugal pumps, the laws governing the performance of geometrically similar fans or pumps are very accurately known, and a series of constant-speed runs at any one speed is all that is required to predict the performance of any size of unit of the same design under any conditions.

In conclusion the writer would like to emphasize the fact that interpolation of the results of tests upon steam turbines, centrifugal fans and centrifugal pumps is far more accurate than one would be led to believe by reading Mr. London's article. It would hardly seem possible that a manufacturer would care to take 50 years to test one size of small turbine completely, when the tests described here, which the writer believes to be sufficient to give an accurate estimate of the performance of this type of turbine, were made in a period of six days.

Annapolis, Md. CHARLES M. REED.

Pitting and Discoloration of Slip Rings

While traveling for a large manufacturing company I encountered many problems—some difficult, others simple—on all sorts and sizes of electrical apparatus. One of the things I noticed was that in many cases the slip rings of synchronous machines offered different appearances. One ring would be clean, the other pitted, sometimes spotted and at other times discolored. Often the cause could be charged to faulty brush mounting, improper brush tension or lack of lubrication; and then in other cases the ring itself was found to be at fault.

On large alternating-current generators of the revolving-pole type fitted with copper collector rings and carbon-brushes, it will often be noticed that the negative ring becomes a blackish color while the positive ring remains bright and polished. The most plausible explanation for this is that it is due to electrolytic action. Copper is an electrically active material, while carbon is not, hence the discoloration appears only on the negative ring, where the current flows from copper to carbon. There is really no serious objection to this electrolytic action except perhaps that it tends to increase the resistance between the brushes and ring and therewith the voltage drop.

Spotting and pitting are generally due to some defect in the rings and generally tend to become worse and worse, since the effect is cumulative. Faulty brush contact may possibly start the trouble, while the flashing over of rotaries is often the cause of flat spots which cause arcing and further aggravate arcing and burning of the ring.

One particularly bad case came to my notice several years ago. One slip ring of a heavily overloaded rotary converter had developed flat spots, due apparently to the metal being soft and spongy in places. There were two brushes per ring, the brushes being of laminated copper, and it so chanced that two flat spots developed, one more advanced than the other. These spots coincided with the brush pitch, which aggravated the trouble because both brushes would arc and burn together. If there had been

only one flat spot or the two spots had not coincided, one brush might have shunted out a portion of the current carried by the other and to some extent relieved the trouble. The load was very heavy, about 50 per cent. overload, and the rings got so bad before I arrived that the hot metallic fumes resulted in the machine flashing over many times a day between the rings.

Examination showed that one ring had two soft spots in it, due to faulty casting, hence it would be of little use to turn it down. To replace the defective ring by a new one was out of the question, as it would necessitate taking off three other rings, slipping the pedestal away before the rings could be got off the shaft and the new one slipped on, with no jack or cribbing available for holding the rotary armature in place. The machine had to be back in service again at all costs within a few hours, as it was carrying the load of another machine which had burned out, and upon which some fifteen miles of interurban railway depended for its supply of energy. It was finally decided to cut the two soft spots out of the ring and replace these spaces with blocks cut from another apparently good ring. The defects were so situated with respect to each other that two men could work together, one on each spot. These were marked off and drilled out while a third man cut two blocks from the spare ring. The spaces were filed out and the new blocks made a good snug fit. Each was about two inches in width and the thickness of the ring.

When these blocks had been driven in place, two holes were drilled in each, half the holes being in the block and half in the original part of the slip ring. These holes were then tapped out with a quarter-inch tap and two dowel pins turned from the spare ring screwed into each hole. These pins were longer than the thickness of the ring, so after having been screwed in as far as they would go, the protruding sections were cut off and the surface turned down. The job was meant to be only temporary to tide over an emergency. Chancing to pass through that territory again about two years later, I visited the station and was pleased to find that the makeshift job was still doing the work. M. A. WALKER.

Chicago, Ill.

Alternator Field Coils Short-Circuited

Several 8-pole 125-kw. 2,300-volt 60-cycle alternators after a number of years of operation were unable to carry full load and hold up the voltage at the rated frequency. As the prime movers were equipped with governors having a switchboard control, the engineers fell into the habit of cutting out all the exciter resistance and regulating the voltage by varying the speed of the engines. This of course made a very noticeable difference in the speed of all induction motors on the system, but was not given any particular attention until a motor-generator set was installed to supply direct current for charging storage batteries. It was then noticed that after changing from one unit to another, which was done daily (the load being small and only one unit being used at a time), the direct-current voltage would drop considerably after the alternator's voltage had been adjusted. This of course was caused by the new machine being able to carry the load at a lower speed for a short time or until it had heated up, thus increasing its resistance, when it would be necessary to speed up if the voltage was to be kept uniform.

It was realized that something was wrong, and considerable discussion followed among the men. Some blamed the exciters, while others laid it to some of the alternator field windings being short-circuited or grounded. At last a representative of the company that manufactured the generators was sent for. After taking voltage and ammeter readings, he declared the exciters were in good shape and the current supplied by them was of a value sufficient to excite two such alternators. He then excited the fields of one of the idle machines with a current at 90 volts across the rings (the alternators being of the revolving-field type), and took the voltage drop across each field coil, which was found to be practically the same. Figuring from the voltage and current readings, he declared that the insulation of the field windings had been partly but uniformly broken down and that the remedy was to rewind the fields.

The reason for the insulation breaking down was attributed to the low power factor (about 65 per cent.). This was doubtless correct, for, as explained in a recent article in *Power*, a lagging power factor gives the armature current a tendency to oppose the field flux, thus necessitating a stronger exciting current. With the low power factor in the present case, the field current must have been very large at full load, thus causing the windings to heat excessively and gradually deteriorate the insulation.

When the fields were rewound, more turns were given and a high grade of insulation was used, a frequency meter was installed and no trouble has been experienced since in carrying 50 per cent. overload at the proper frequency. A. C. MCHUGH.

Del Monte, Calif.

Rigid Cylinder Supports

My views on the subject of rigid cylinder supports, in connection with the letter by Mr. Stewart in the issue of Sept. 12, page 393, are that the practice of rigidly bolting the cylinder to a pedestal is wrong and unnecessary. In large engines the length of the cylinder is considerably increased by expansion when heated up to the temperature of the steam, and unless it is supported in the middle or is free to move at one end, there will be considerable strain set up in the cylinder and frame of the engine. The holding-down bolts usually, being the weakest link in the chain, will break, and it is better that they should give way and relieve the strain, for the cylinder might be sprung and the alignment of the entire engine be disturbed, if the bedplate escaped being broken.

Large gas engines have the main frame securely anchored, but the cylinders or the housings between the cylinders of a twin-cylinder engine are supported by machined feet and rest on ways which allow free longitudinal movement. This movement is considerable, in some cases as much as $^1/_{64}$ of an inch on a 600-hp. engine. H. A. FISHER.

New Haven, Conn.

The Accepted Theory of Corrosion is the electrolytic theory, according to which one spot in a piece of metal is electro-positive and another electro-negative. Moisture or water connecting the two spots completes a circuit, causing a flow of electricity from one to the other, the metal going into solution at the place from which the current flows.

Inquiries of General Interest

Negative Lap of Valve—What is meant by negative lap of a valve? R. C.

Negative lap is the amount by which the valve fails to cover the port when the valve is in the middle of its travel.

Automatic Feed Pump and Receiver—What capacity of pump should be used in an automatic feed pump and receiver for handling the condensate from steam-heating apparatus? D. L. E.

The size of pump should be calculated on the basis of ½ lb. of steam condensed per hour per square foot of radiating surface, allowing, as in boiler-feed pumps, for one-half the piston speed employed for regular service.

Variation of Expansion Lines on Indicator Diagram—On an indicator diagram taken from a cutoff engine, what causes a number of expansion lines to be drawn, one above another, without change of the load on the engine? C. W.

Assuming that neither the indicator nor the method of taking the diagrams is at fault, the variation of expansion lines would be due to the presence of a variable volume or pressure of steam at the time cutoff takes place or to irregular leakage of the valves. A variation of volume before cutoff and also of pressure due to the throttling action of the steam valves would result from variation of the governor position or irregularity in the action of the cutoff mechanism.

Removing Scale from Injector Tubes—How can injector tubes be cleaned of scale and mud deposits? W. J. G.

Remove the tubes from the body of the injector and cleanse of any grease by washing them in a strong solution of potash and hot water; and after washing in clean hot water dip the parts in a solution of 1 part muriatic acid and 10 parts water, though only long enough to soften the deposits, after which the tubes should be quickly washed in clean cold water to stop the corrosive action of the acid. Any remaining deposits that are not readily removed after washing should be further softened by local application of the acid solution, taking care in each application to wash the tubes clean of all traces of the acid.

Speeding up Engine with Throttling Governor—How can an engine with a throttling governor be speeded up? W. M.

By placing a smaller pulley on the engine shaft for driving the governor or a larger receiving pulley on the governor, so that a higher engine speed will be required to cause the governor to check the speed of the engine. Most modern throttling governors are provided with springs or weights for varying the resistance offered to the centrifugal force that is exerted by the governor balls. If the governor is thus equipped, the engine can be governed at a higher speed by increasing that resistance or, as commonly termed, increasing the loading of the governor, thus requiring the attainment of centrifugal force of a higher speed for checking the speed of the engine.

Percentage of Pump Slippage Less for Higher Speed—How is it explained that the piston slippage of a pump is greater for slow speeds than for high speeds? H. T. C.

Pump slippage is usually rated as a percentage of the piston displacement, and when pumping against a stated pressure, the leakage past the piston would take place at practically the same rate at one speed as at another. When the piston leakage per stroke is less than the piston displacement, the actual delivery per minute for a given speed bears a higher ratio to the constant rate of leakage than when there is less delivery per minute at a slower speed. Hence, at the higher speed the delivery is a higher percentage of the piston displacement and the slippage becomes a less percentage of the displacement.

Air Pressure Required for Air Lift—We have a well in which the water stands about 25 ft. below the surface of the ground and wish to raise the water with an air lift to a tank about 50 ft. high. What air pressure will be required? H. B. W.

For injection of the air its pressure must be sufficient for overcoming the pressure of the well water at the depth of submergence of the air pipe. The well-water pressure in pounds per square inch will be equal to the depth in feet multiplied by 0.433. Additional pressure, ordinarily 3 to 5 lb. more, will be required at the air compressor for overcoming friction of the air line, depending on the size and length of the air line and other frictional resistances. Most economical results are usually obtained when the submergence of the air lift (that is, below the surface of the well water) is 55 to 65 per cent. of the total air lift. With an actual water lift of $25 + 50 = 75$ ft. and 60 per cent. submergence, the actual lift, or 75 ft., would be 40 per cent. and therefore the 60 per cent. submergence would be $(75 \times 60) \div 40 = 112.5$ ft. This would require an injection air pressure of $112.5 \times 0.433 =$ 48.7 lb. per sq.in. for overcoming the well-water pressure, and for overcoming friction as referred to, the air would have to be compressed to somewhat higher pressure by the compressor.

Determining Coal Per I. Hp.-Hour—What would be the method of determining the coal per horsepower hour for a moderate-sized steam plant? L. M. L.

The coal per horsepower-hour for a given period would be the required coal consumption per hour for the power plant divided by the average horsepower developed. In stating the horsepower, the indicated is usually understood. The percentage of error due to a difference of conditions at the beginning and end of the test will be less the greater the whole period of time over which the test extends. Indicator diagrams for measurement of the power should be taken simultaneously from both ends of the engine cylinder at regular intervals during running hours, and the shorter the intervals between diagrams the less the percentage of error. A test extending over a week divided into half-hour periods will usually answer all practical requirements. The diagrams should be taken in the middle of each period, and the average power should be the average value of all such diagrams taken during the whole period of test. The total weight of coal used divided by the total number of hours run will give the coal used per hour, and this divided by the average power will be the coal per horsepower-hour inclusive of coal required for banking furnace fires. To determine the coal per horsepower-hour exclusive of coal required for banking fires, of course the coal so used should not be included. On each day the periods for taking indicator diagrams should begin and end with the same amount of coal on the grates and the same condition of fires, as nearly as can be estimated.

Determining Steam Available for Low-Pressure Turbines—How can the amount of exhaust steam available for low-pressure turbines be determined in a case where steam hammers are supplied with all the steam generated by the boilers and part of the exhaust is used for exhaust-steam heating? S. E.

The weight of steam available for the low-pressure turbines would be the steam used by the steam hammers less the weight of condensate discharged by drips and the weight of steam required by the heating apparatus. On account of the intermittent operation of a number of steam hammers, it would be well to base the calculations on the minimum steam available. It might be necessary to measure the flow of steam to the hammers by means of a steam meter to determine the amount of steam flowing under ordinary working conditions; or the steam available can be approximated by checking a continuous record of the feed water against variations of water contained by the boilers, known from variations of boiler-water levels. For determining the loss from drips continuous record should be obtained of the weight of condensate discharged as drips from the exhaust of the hammers, including the discharge by drips at points where the exhaust is to be drawn by the turbines and also at places where the heating apparatus is supplied.

The amount of exhaust used for heating is most accurately ascertained by gathering and weighing the condensate discharged by the heating apparatus when operated in coldest weather. If a vacuum system of heating is employed, the amount of cooling water added to the condensate discharge must be accounted for. If dependence on a cold-weather test of the heating apparatus is impracticable, the steam required for heating would have to be determined by the usual methods employed in designing steam-heating apparatus.

[Correspondents sending us inquiries should sign their communications with full name and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Smoke Prevention Convention Held at St. Louis

At the Planters Hotel, St. Louis, from Sept. 26 to 29, the Smoke Prevention Association held its eleventh annual convention. The total registration was 86, which was 30 per cent. greater than last year. Members of the Engineers' Club of St. Louis and visitors helped to swell the attendance, so that the convention was a decided success.

The first session opened Tuesday morning with President W. A. Hoffman in the chair. C. H. Daues, city counselor, gave the address of welcome and W. M. Chauvenet added a few words in behalf of the Joint Smoke Prevention Committees of St. Louis. President Hoffman responded briefly. Next in order was the reading of the minutes for the 1915 convention and other routine business. An important feature of the morning session was the report of the standardization committee, consisting of twelve members, each having been assigned a subject. The composite report was comprehensive and practically covered the entire field of the smoke inspector. The first of the individual reports dealt with ordinances. A violation was defined and standard permit and certificate of operation clauses were suggested. Other standards presented were: A report sheet for the city smoke inspector; a standard method of grading the density of smoke; a standard form for entering records; standard specifications for dampers, breeching and stack; a standard formula for figuring the draft intensity of the stack; standard specifications for the use of firebox heating boilers, telling where down-draft, underfeed and other types of furnace can be used and where dispensed with; standard stack sizes for heating boilers; and a standard method of installing steam jets, although their use was discouraged by the committee. In addition there were presented standard specifications for installing brick-arch, wing-wall and other furnaces where firebrick is used to mix the gases. An interesting report on front-feed stokers showed standard methods of setting with different types of boilers, and another section dealt with standard methods of applying chain grates to different types of water-tube boilers. A report on locomotive practice suggested standard methods of firing in service, of building up the fire, and of applying brick arches, steam jets, etc. These various standards will be given a year's trial before they are officially adopted by the convention.

SMOKE PRODUCED BY HEATING PLANTS

The first paper of the afternoon session, entitled "The Smoke of Heating Plants," by O. Monnett, of Chicago, gave the proportion of heating to total smoke in various cities of the country. In Chicago, where the fuels for heating run as high as 38 per cent. anthracite, the heating smoke averages from 15 to 20 per cent. of the total. In cities burning no hard coal the proportions run as high as 40 to 50 per cent. during the heating season. It was pointed out that smoke from heating boilers was much more detrimental than the smoke from high-pressure plants, because of the presence of tarry matter and unignited distilled creosote passing off at relatively low temperatures. Besides damaging buildings, vegetation, etc., these products often cause acute lung diseases, so that it is of the greatest importance to give more attention to the study and regulation of heating plants.

W. A. Pittsford, of Chicago, read a paper on "Heating Boilers and Furnaces," tracing the evolution of arch building over chain grates during the last 12 years and suggesting a standard setting. By means of colored slides the speaker showed the complete cycle of operation of down-draft heating boilers. Although standardization of settings is to be desired, it is just as important to insist on proper areas in the damper, breeching and gas passages of the boiler. It should be one of the functions of the smoke inspector to check up the areas.

At the session of Wednesday morning J. W. Henderson, chief of the Bureau of Smoke Prevention in Pittsburgh, told of the progress made in that city. He said that favoritism and political influence had been set aside, that publicity had proved most effective in securing public interest and coöperation, and that criticism and comments were welcome and were given full publicity in the daily press, so that the people would understand the questions at issue and know who was opposing the work of the department. Lantern slides showed the wonderful improvement made since 1912—the improved condition of the mills and the great reduction in smoke from the railways. The importance of the stoker in securing these results was emphasized.

"Chimney Draft and Its Relation to Boiler and Furnace Efficiency" was the title of the next paper, by E. R. Fish, of the Heine Safety Boiler Co. The speaker outlined the advantages of natural draft and the use of forced and induced draft for high rates of combustion. This paper will be presented in a later issue.

After luncheon with the Business Men's Club, the conventioners viewed the smoke areas of St. Louis from the top of the Railway Exchange Building. At a short afternoon session Joseph G. Worker delivered an illustrated lecture on the "Development of the Stoker and Its Relation to Smoke Abatement." In the introduction the speaker outlined the desires of the public, the possibilities in operation and the problems of the manufacturer in making equipment for smokeless operation. He pointed out that all large central stations are now operated with very little smoke. The superintendent of motive power is vitally interested, and the firemen are trained to operate boilers along scientific lines. The proper use of instruments has been a great factor in obtaining present-day economy. Great progress has been made in the utilization of coal, and specifications now state the operating conditions under which the stoker is to work. The characteristics of the various types of stoker were enumerated, and the Westinghouse underfeed stoker was thoroughly described and illustrated. It was pointed out that high efficiency at normal rating with a wide range of operation and large reserve capacity is the prime factor of the underfeed stoker rather than large steaming capacity. The discussion turned to the use of bauxite brick and water boxes rather than the use of ordinary firebrick to prevent clinkers from sticking to the side walls. The spacing between settings and the use of side doors in connection with the under-feed stoker were other points of discussion.

Wednesday evening those attending the convention were guests of the Engineers' Club and the Associated Engineering Societies of St. Louis. An illustrated paper on "Soot Fall Studies," by John J. O'Connor, Jr., who is a member of the faculty of Mellon's Institute of Industrial Research, University of Pittsburgh, was received with much interest. The speaker explained the various methods of measuring soot used in Great Britain and this country. Statistics on the amount of soot fall in various cities and an illustrated description of the standard method of measuring soot adopted at the London convention were given. It was pointed out that pure air should receive as much attention as pure water. Some standard method of measuring soot should be adopted and records kept in the various cities of the country. Music, dancing and light refreshments followed the paper.

THE RAILROAD SESSION

Thursday was railroad day. Papers were presented on "Burning Powdered Coal on Locomotives," by C. W. Corning, of the Chicago & Northwestern Ry.; "Railroad Smoke Elimination," by H. H. Maxfield, of the Pennsylvania R.R.; "Firing up Engines at Engine Roundhouses," by A. E. Langreck, general foreman of the Terminal Railroad Association of St. Louis. The last-named paper was accompanied by a moving picture showing in complete detail the method used by the Pennsylvania R.R. In the afternoon practical demonstrations of firing up engines were given.

Friday morning was devoted to the presentation of a paper on "The Carburization and Burning of Powdered Coal as Fuel," by Alonzo G. Kinyou, of Chicago. Following an introduction giving the principles of combustion, the author outlined the cause of smoke formation and emphasized the importance, in the use of powdered coal, of fineness and intermingling of the coal with the air supply. This was followed by an outline of the Pruden method of burning powdered coal. A lengthy discussion on the cost of pulverization and the various characteristics of powdered coal followed.

Officers elected for the ensuing year were: W. H. Reid, chief smoke inspector of Chicago, president; Marten Rooney, chief smoke inspector of Nashville, Tenn., first vice-president; W. L. Robinson, supervisor of fuel consumption of the Baltimore & Ohio Ry., second vice-president; A. A. Chambers, of Chicago, secretary-treasurer. Columbus, Ohio, was chosen as the next convention city. A trip to the Anheuser-Busch brewery was the closing feature of the convention.

In Cases of Foaming reduce the furnace temperature by checking the draft or by shutting off the fuel supply if oil or gas is used. Throttle the steam line if possible. These should stop it unless something is radically wrong, which must be determined by shutting down the boiler.

BOOKS RECEIVED

AUTOMOBILE HANDBOOK. By J. E. Homans. Sully & Kleinteich, New York. Cloth; 5x7¼ in.; 248 pages; illustrated. Price, $1.

THE SUBMARINE TORPEDO BOAT. By Allen Hoar. D. Van Nostrand Co., New York. Cloth; 5½x8 in.; copiously illustrated; plates. Price, $2.

FIRST PRINCIPLES OF ELECTRICITY. By J. E. Homans. Sully and Kleinteich, New York. Cloth; 5x7¾ in.; fully illustrated; tables. Price, $1.

PRACTICAL SAFETY METHODS AND DEVICES. By George A. Cowee. D. Van Nostrand Co., New York. Cloth; 6¼x9¼ in.; 434 pages; 127 illustrations. Price, $3.

PRINCIPLES OF ALTERNATING CURRENT MACHINERY. By Ralph H. Lawrence. McGraw-Hill Book Co., Inc., New York. Cloth; 5¾x8¼ in.; 273 illustrations. Price, $4.50.

WATERWORKS HANDBOOK. By Alfred D. Flinn, Robert S. Weston and Clinton L. Bogert. McGraw-Hill Book Co., Inc., New York. Flexible leather; 6x9¼ in.; 410 illustrations; tables. Price, $6.

OBITUARY

Frank E. Shedd, vice-president and chief engineer of Lockwood, Greene & Co., engineers, Boston, and prominent in hydraulic and industrial engineering circles, died at Boston, Sept. 23.

James Lumsden, treasurer of the steam piping contracting firm of Lumsden & Van Stone, Boston, died suddenly on a hunting and fishing trip near Bingham, Me., Sept. 25. Mr. Lumsden was fifty-two years of age and had been in poor health for the past two years. He was a director of the Federal Trust Company, Boston, and was widely known in engineering circles.

John E. McIntosh, one of the founders of McIntosh, Seymour & Co., died Sept. 17 at his summer home in Cayuga, N. Y., after a sudden illness of a few days. Mr. McIntosh was in his fifty-eighth year and together with James Alward Seymour founded, in 1886, the engine business of McIntosh & Seymour, which grew to very large proportions. In 1912 Mr. McIntosh retired from active business and has since spent most of his time at his summer home in Cayuga. He always took a strong interest in public affairs and served two terms as Mayor of Auburn and has represented the business interests of Auburn at a great many commercial and public gatherings. In later years he was much interested in the subject of internal waterways.

TRADE CATALOGS

Electric Motors. Stow Manufacturing Co., Binghamton, N. Y. Bulletin No. 100. Pp. 20, 6x9 in. Illustrated.

Horizontal Power Pumps. National Transit Pump and Machine Co., Oil City, Penn. Bulletin No. 201. Pp. 20; 6x9 in.; illustrated.

Steam Pumps, Block Valve Type. National Transit Pump and Machine Co., Oil City, Penn. Bulletin No. 107. Pp. 8; 6x9in.; illustrated.

Induction Motors for Two- or Three-Phase Alternating Current. The Lincoln Electric Co., Cleveland, Ohio. Bulletin. Pp. 48; 8x10½ in.; illustrated.

Lubrication and Casings for Silent-Chain Drives. Link-Belt Co., 39th St. and Stewart Ave., Chicago, Ill. Booklet No. 286. Pp. 8; 6x9 in.; illustrated.

Oil Engines. De La Vergne Machine Co., Foot East 138th St., New York. Bulletin No. 158. Pp. 16; 8½x11 in. This illustrates and describes Type "DH" crude-oil engine.

Pipe Fittings, Valves, Cocks, Etc., for Steam, Gas, Water, Air and Oil. The Kelly & Jones Co., Pittsburgh, Penn. General Catalog and Price List. Pp. 470; 5x7½ in.; illustrated.

Multivane Fans, Design No. 3. B. F. Sturtevant Co., Hyde Park, Boston, Mass. Bulletin No. 228. Pp. 100; 8½x11 in. This contains advance information, dimensions, capacities, horsepowers, etc.

Economizers. B. F. Sturtevant Co., Hyde Park, Boston, Mass. Bulletin No. 222. Pp. 20; 8½x11 in. This shows the installations of economizers in the power plants of a number of prominent paper mills.

Boilers. The D. Connelly Boiler Co., Cleveland, Ohio. Catalog. Pp. 23; 8½x12 in. This describes the Connelly water-tube boiler in detail, together with views showing the method of supporting the boilers in their setting.

Incrustation, Corrosion, Foaming and Other Effects of Water Used in Steam Making and Methods of Prevention is the title of a 32-page booklet issued by the Dearborn Chemical Co., McCormick Building, Chicago, Ill., which ought to be useful to those interested in the subject of boiler water.

Sturtevant Heaters. B. F. Sturtevant Co., Hyde Park, Boston, Mass. Catalog No. 230. Pp. 132; 8½x11 in. In addition to describing the operation, construction and mechanical details of Sturtevant heaters, performance tables, diagrams and dimensions are included which ought to be of benefit to engineers, architects and steam fitters.

Electric Fans. B. F. Sturtevant Co., Hyde Park, Boston, Mass. Catalog No. 240. Pp. 60; 8½x11 in.; illustrated. Contains information on sizes and types of Sturtevant motor-driven fans and includes capacities and net prices. Also data are supplied covering pressures, volumes, sizes, etc., to guide in the selection of a small fan for any specific purpose.

ENGINEERING AFFAIRS

The American Iron and Steel Institute will hold its next meeting at St. Louis, Mo., Oct. 27-28.

The Ohio Society of Mechanical, Electrical and Steam Engineers will hold its annual meeting at Columbus on Thursday, Nov. 16, the council having decided to try a one-day intensive meeting instead of spreading the sessions over a number of days, as usual. Among the topics announced for consideration are the advisability of holding only one meeting a year in the future and of combining with the Ohio Engineering Society.

The Fourth Annual Efficiency and Welfare Conference under the auspices of the Pennsylvania State Department of Labor and Industry and the Engineers' Society of Pennsylvania will be held at the Capitol, Harrisburg, Nov. 21-23. Representatives of most of the state's large industries and many engineering authorities will be present to discuss various legislation affecting industrial establishments and other problems. The complete program will be announced later by Commissioner John Price Jackson.

The National Safety Council will hold its annual meeting and congress in Detroit, Oct. 17-20, at the Hotel Statler. This council, an employers' organization, was started a little less than three years ago in the United States for the purpose of establishing a clearing house of information on accident prevention, sanitation, health conservation, etc. Remarkable progress has been made; starting with 40 members, the council now has more than 2,200 and has extended its influence to many foreign countries. The program for the coming meeting contains the names of 140 speakers. The development of the council's work has indicated the need for intensive study of the problems of various industries, so that the main feature of the meeting this year is Sectional conferences. For instance, the electric light and gas industry members will be assembled in the Public Utilities Section. A new feature of the congress this year will be a mammoth safety exhibit, where the latest types of safety devices will be shown.

PERSONALS

Edward J. Cheney, formerly connected with the engineering staff of the General Electric Co., of Schenectady, N. Y., succeeds Edward McGuire, who has resigned as chief of the division of light, heat and power, Public Service Commission, Second District, New York.

Ambrose B. Dean, for 16 years Eastern sales manager for A. E. Keeler Co., has severed that connection and opened an office at 39 Cortlandt St., New York, for the sale of steel boilers, both water-tube and fire-tube types, and riveted-plate construction, as manufactured by the Union Iron Works, of Erie, Penn.

Prof. E. A. Fessenden, who was for several years with the Etna Foundry and Machine Co., of Springfield, Ill.; the Babcock & Wilcox Co., Bayonne, N. J.; the Westinghouse Machine Co., Pittsburgh, and more recently associate professor of mechanical engineering in the University of Missouri, has been elected head of the department of mechanical engineering of the Pennsylvania State College.

D. C. Green, formerly connected with the organization of H. M. Byllesby & Co. as local manager at two Oregon and Washington properties, has been appointed general manager of the Fort Smith Light and Traction Co., Fort Smith, Ark., succeeding H. C. Hoagland, who has been managing that property in connection with his work as manager of the Muskogee Gas and Electric Co. for some time past. Mr. Hoagland will continue as manager of the latter company.

Clarence H. Nichols has succeeded Winfield A. Haller as general superintendent and chief engineer of the Federal Light and Traction Co., New York City.

H. W. Rand, formerly with the Federal Metallic Packing Co., is now with the Chapman Valve Manufacturing Co., with headquarters at the home office, Indian Orchard, Mass.

Ray Palmer, formerly commissioner of gas and electricity for the City of Chicago, has been appointed president and general manager of the New York & Queens Electric Light and Power Co., with headquarters at Long Island City.

Peter Junkersfeld, who is assistant to the vice-president of the Commonwealth Edison Co. of Chicago and a prominent member in many American engineering societies, was elected president of the Association of Edison Illuminating Companies at its last annual convention.

Proposed Construction

Calif., Colusa—City plans electric-light plant.

Idaho, De Lamar—Electric Investment Co., Boise, plans to extend its transmission line from De Lamar to Jordan Valley.

Ill., DeKalb—DeKalb-Sycamore Electric Co. plans to enlarge power plant.

Ind., Sullivan—Sullivan County Electric Co. making plans for extending its service in Sullivan County.

Iowa, Ft. Madison—City making plans for one-story, 34x44-ft. power house. H. F. Liebbe, State Capitol Bldg., Des Moines, architect.

Iowa, Iowa Falls—Iowa Falls Heat, Light and Power Co., Iowa Falls, granted franchise to extend transmission lines to Alden.

Kan., Augusta—City voted $10,000 bonds for improving and extending electric-light plant and system.

Mass., Charlton—Newburyport Gas and Electric Co. plans transmission line across Merrimac River to Rings Island to connect with system of Amesbury Electric Light Co.

Man., Winnipeg—Board of Control plans transmission line from city's Point du Bois electric power plant to Rice Lake gold fields, 60 mi. G. J. Brown, city clerk.

Mich., Manistee—Consumers Power Co., Jackson, plans dam on Manistee River to develop about 22,000 hp.

Mich., Pontiac—Detroit Edison Co. applied to city for permission to build substation, about $75,000.

Neb., Norfolk—Neb., Tilden—Nebraska Gas and Electric Co. plans to extend transmission line from Tilden to Oakdale, about 10 mi.

Neb., York—Public Service Corporation making plans for one-story, reinforced-concrete power house. About $20,000 cost of construction and $50,0000 additional for machinery and equipment.

N. C., Madison—City voted $8,000 bonds for electric-light and power system.

N. D., Granville—Bacon & Burr plan to install electric-light plant in Granville.

N. D., Halliday—J. F. Wenrick plans to install electric-light plant.

N. Y., Niagara Falls—International Ry. Co. of Buffalo plans substation at 24th St. and Allen Ave. J. C. Sheldon, Buffalo, Purchasing Agent.

N. Y., Niagara Falls—Titanium Alloy Manufacturing Co. will receive bids for one- and 2-story, 46x53-ft. boiler house.

Ohio, Martins Ferry—City plans to improve electric-light plant.

Ohio, Massillon—City plans electric-light system.

Okla., Buffalo—City election Oct. 11 to vote on $15,000 electric-light plant bonds.

Okla., Canton—O. A. Hunt, Watonga, interested in electric-light plant in Canton.

Okla., Mountain View—City voted $8,000 bonds for electric-light plant.

Okla., Skiatook—City plans electric-light system.

Okla., Woodward—Citizens voted $15,000 bonds for electric-light plant.

Ont., Dunnville—City plans electric-light plant. About $53,000.

Ont., Hamilton—City Council plans substation. S. H. Kent, city clerk.

Ont., Mt. Dennis—City plans hydro-electric system.

Ont., Petrolia—Union Natural Gas Co. plans 2-mi. high pressure gas line. F. James, Chatham, manager.

Ont., Toronto—Toronto Electric Commission making plans for substation on Jefferson Ave. About $20,000.

Penn., Aldan—Delaware County Electric Co., Lansdowne, to install electric-lighting system in Aldan.

Penn., Bristol—W. J. Steel plans power plant.

Penn., Chester—Philadelphia Electric Co. plans 120,000 kw. generating plant. About $6,000,000.

Penn., Eddystone—Philadelphia Electric Co. plans substation in Eddystone.

Penn., Philadelphia—Sisters of Mercy Hospital, Cedar Ave., making plans for power house. E. F. Durang & Sons, Architect.

Penn., Waymart—Scranton Electric Co., Scranton, plans to extend transmission lines to Waymart.

S. C., Camden—City voted $7,000 bonds for electric-light plant. C. H. Yates, mayor.

S. C., Pamplico—Dargan-Wagner Lumber Co. plans electric-light plant.

Tenn., Beardon—Colonial Lumber Co. plans electric-light plant. H. D. Wyrick, manager.

Tex., Atlanta—Atlanta Electric and Ice Co. plans to rebuild electric-light plant and ice factory. About $40,000.

Tex., Burnet—W. C. Galloway, First National Bank, plans electric-light plant.

Tex., Wichita Falls—Wichita Falls Electric Co. increased its capital stock from $700,000 to $775,000 and will improve its plant.

Va., Williamsburg—E. H. Clowes and associates, Richmond, granted franchise by Council to construct electric-light plant.

W. Va., Webster Springs—Webster Springs Power Co. plans dams on Elk and Gauley Rivers, Webster County.

Wis., Hortonville—Company will be organized to take over holdings of Hortonville Light Heat and Power Co. and install electric-light plant in Hortonville.

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The Output of Bituminous Coal in the United States during the first six months of 1916 was the greatest ever recorded in any half-year period. Estimates by C. E. Lesher, of the United States Geological Survey, based on returns from over 100 railroads originating coal and coke shipments, indicate that the production during this period was 261,000,000 tons, an increase of 35 per cent. over the first six months of 1915 and of 5 per cent. over the last six months of the same year, and greater by several million tons than the record established in the last half of 1913. Compared with the first half of 1915, the exports from the Atlantic seaboard during the last six months have increased about 10 per cent. and the exports to Canada have nearly doubled. The movement of bituminous coal through the Soo Canal on the Great Lakes shows an increase of 80 per cent., and the coal used in coking has increased nearly half. The output of beehive coke has increased from about 11,250,000 tons in the first half of 1915 and 16,250,000 tons in the second half of 1915 to more than 18,000,000 tons during the last six months. The manufacture of coke in byproduct ovens has also increased as new ovens have been completed and put in commission.

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STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912,

of Power, published weekly at New York, N. Y., for October 1, 1916.

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the State and County aforesaid, personally appeared Chester W. Dibble, who, having been duly sworn according to law, deposes and says that he is the Vice-President of Hill Publishing Co., Publishers of Power, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor and business manager are:

Publisher, Hill Publishing Company, 10th Ave. at 36th St., New York, N. Y.

Editor, Fred R. Low, 10th Ave. at 36th St., New York, N. Y.

Managing Editor, Alfred D. Blake, 10th Ave. at 36th St., New York, N. Y.

Business Manager, George E. Andrews, 10th Ave. at 36th St., New York, N. Y.

2. That the owners are:

Hill Publishing Company, 10th Ave. at 36th St., New York, N. Y.

Owners of 1% or more of Stock Issued.

Estate of John A. Hill, 10th Ave. at 36th St., New York.
Arthur J. Baldwin, 10th Ave. at 36th St., New York.
Fred R. Low, 10th Ave. at 36th St., New York, N. Y.
John McGhie, 10th Ave. at 36th St., New York, N. Y.
Fred S. Weatherby, 1600 Beacon St., Brookline, Mass.
Frederick A. Halsey, 356 W. 120th St., New York, N. Y.
G. Eugene Sly, 50 Union Sq., New York, N. Y.
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Emma B. Hill, 80 Munn Ave., East Orange, N. J.

The remaining stock is owned by 91 stockholders who own less than 1% each, 73 of whom are employees of the company.

3. That the known bondholders, mortgagees and other security holders owning or holding 1 per cent. or more of total amount of bonds, mortgages or other securities are: Mortgage on building, Dime Savings Bank, Brooklyn, N. Y.

4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association or corporation has any interest direct or indirect in the said stock, bonds or other securities than as so stated by him.

CHESTER W. DIBBLE,
Vice-President, Hill Publishing Co.

Sworn to and subscribed before me, this 29th day of September, 1916.

[Seal.] RICHARD L. MURPHY.
(My commission expires March 30, 1917.)